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PRIZE THESIS.
AN
EXPERIMENTAL INQUIRY,
CONCERNING THE
PRESENCE OF ALCOHOL
IN THE VENTRICLES OF THE BRAIN,
AFTER POISONING BY THAT LIQUID;
TOGETHER WITH
EXPERIMENTS,
ILLUSTRATIVE OF THE PHYSIOLOGICAL ACTION OF ALCOHOL.

ILLUSTRATIVE OF THE PHYSIOLOGICAL ACTION OF ALCOHOL:

FOR WHICH,

A GOLD MEDAL WAS AWARDED BY THE MEDICAL FACULTY OF THE
UNIVERSITY OF EDINBURGH.

BY JOHN PERCY, M.D.

PRESIDENT OF THE ROYAL MEDICAL SOCIETY OF EDINBURGH, AND FELLOW OF
THE BOTANICAL SOCIETY OF EDINBURGH.



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TO

ROBERT CHRISTISON, M.D.

PROFESSOR OF MATERIA MEDICA IN THE UNIVERSITY OF
EDINBURGH,

PRESIDENT OF THE ROYAL COLLEGE OF PHYSICIANS
OF EDINBURGH, &c.

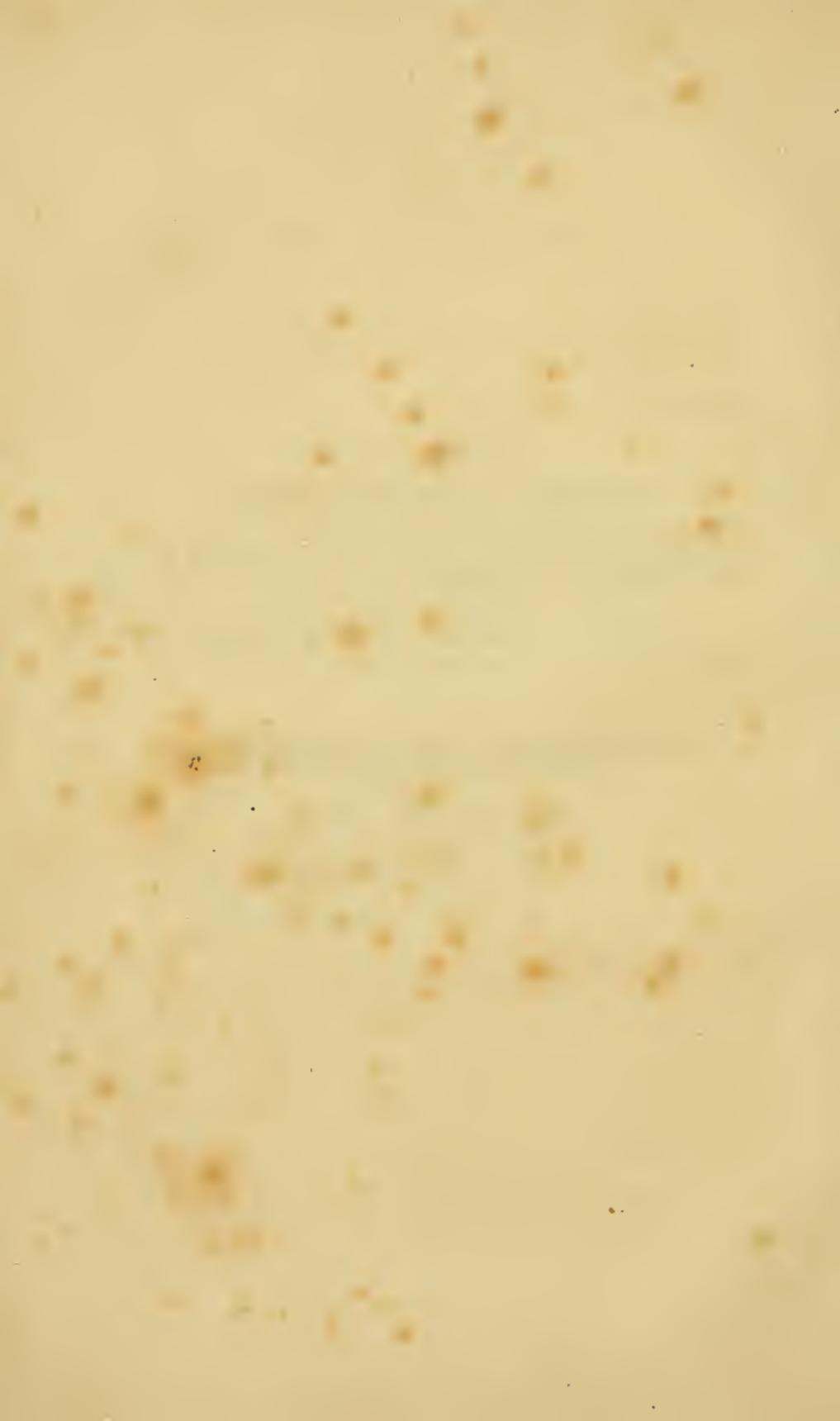
THIS

INAUGURAL DISSERTATION

IS, WITH PROFOUND RESPECT,

DEDICATED BY HIS ATTACHED PUPIL,

THE AUTHOR.





EXPERIMENTAL INQUIRY, &c.

When we reflect upon the great variety of objects which the Physician is required to examine, in the attainment of his profession, there would appear to be no deficiency of matter for an inaugural Dissertation; for the science of Medicine may be justly compared to an edifice formed of the most diversified materials, the foundation alone being composed of those sciences which embrace both the animate and inanimate kingdoms of nature, as Anatomy, Chemistry, Botany, Physiology, &c. When, however, we seek to beat out a new track, or to pursue one which has been but little frequented, we meet with difficulties which cannot be surmounted without labour and perseverance. Nevertheless, the Author has been induced to take up a line of inquiry which, in some respects, he conceives to be original.

Objections having been urged against the remarkable and well-known statements of Dr. Ogston and others, concerning the presence of alcohol in the ventricles of the brain, after poisoning by alcoholic liquors, it occurred to the Author that a series of experiments upon animals might possibly throw some light upon the subject. Accordingly the last vacation was devoted to such an experimental investigation, the fruits of which, combining some degree of interest and novelty, the Author now ventures to present in the form of an inaugural Dissertation.

In reference to the arrangement intended to be pursued, a little explanation is required. As opportunities of observing the various physiological effects of alcohol have necessarily occurred in the course of the investigation, the following pages will not be confined merely to the relation of those results which bear immediately upon the object of the inquiry: the various symptoms and post-mortem appearances, occasioned by the exhibition of alcohol, will also be introduced. Hence the impossibility of avoiding occasional digression.

There is yet another subject which cannot be allowed to pass unnoticed in the prefatory remarks of the present Dissertation—namely, the legitimacy of extending to man the physiological inferences derived from experiments upon the lower animals. That in some instances we are not warranted in so doing, no doubt can be entertained: thus the jugular of a dog may be tied without risk of dangerous consequences; whereas, it is scarcely necessary to add, that in man the same operation is generally attended with fatal phlebitis. But it would seem, that greater uniformity of result prevails with regard to the action of poisons. It is true, that the *susceptibility* of a particular tissue in man, may be greater than that of the corresponding tissue in an animal, as for example, in a dog; or vice versa; yet the *modus operandi* may be the same in both cases. Thus, if a poison be found to produce the same symptoms in man as in a dog, and if the post-mortem appearances in both be found to be identical *in kind*, though, perhaps, not *in degree*, we may reasonably conclude, that the *modus operandi* of such a poison is the same in man as in a dog. Now,

alcohol may be cited in illustration of such a poison ; for alcohol produces the same symptoms, and the same post-mortem appearances in man as in a dog. The Author, therefore, concludes, that he is justified in the present investigation.

Of the cases recorded, in which it is reported that alcohol was detected in the ventricles of the brain, after poisoning by alcoholic liquids, the following will suffice for illustration :—

In the treatise of Dr. Cooke on Nervous Diseases, it is thus stated : “ I am informed by Mr. Carlisle, that ‘ a few years since, a man was brought dead into the Westminster Hospital, who had just drunk a quart of gin for a wager. The evidences of death being quite conclusive, he was immediately examined ; and within the lateral ventricles of the brain, was found a considerable quantity of a limpid fluid, distinctly impregnated with gin, both to the sense of smell and taste, and even to the test of inflammability.’ The liquid,

says Mr. Carlisle, ‘ appeared to the senses of the examining students, as strong as $\frac{1}{3}$ gin, to $\frac{2}{3}$ water.’ ” *

Another remarkable instance of the presence of alcohol in the ventricles of the brain, has been published by Dr. Ogston, of Aberdeen, in his interesting collection of cases illustrative of the “ phenomena of the more advanced stages of intoxication.” † “ The presence of alcohol,” writes Dr. Ogston, “ has been detected in the ventricles of the brain, several cases of this kind being upon record. Doubts, however, having lately been thrown on the accuracy of these instances, I am happy to be able to add one to their number.— The body of a woman, æt. 40, of the name of Caltie, who was believed to have drowned herself in a state of intoxication, was found on the 23d of August, in the Aberdeenshire canal. In company with another medical man, I was requested to inspect the body, in order to report the cause of death, no one having witnessed the

* Treatise on Nervous Diseases, v. 1, p. 221. Vide also Paris’ Pharmacologia, 8th ed. p. 109.

† Edinb. Med. and Surg. Journal, v. 40.

act. In addition to the usual appearances in drowned persons, we discovered nearly 3iv. of fluid in the ventricles, having all the physical qualities of alcohol, as proved by the united testimony of two other medical men, who saw the body opened, and examined the fluid. The stomach also smelt of this fluid.” *

Now, the accuracy of these statements has been called in question by a very distinguished

* Vol. 40, p. 293. The following cases also bear upon the subject :—

“ In a man who died of long continued intoxication from immoderate drinking, Dr. Wolff found that the surface, and still more the ventricles, of the brain had a strong smell of brandy, although the contents of the stomach had not.”—Christison on Poisons, 3d ed. p. 853.

Vide also “ Lancet,” v. 1, 1836-37, p. 271, where a case is recorded, in which, after the exhibition of 3ss. of sulphuric æther, “ a strong smell of æther was perceived” after the removal of the calvarium. Drs. Elliotson and Carswell, and Mr. Liston were present. “ Very moderate effusion in the lateral and fourth ventricles, which smelt strongly of æther, and a piece of lint soaked in, and held in the flame of a candle, was thought by the gentlemen present, to blaze up rather more than a piece of lint dipped in water, the experiment being made with water also at the same time.”

I may further state, that in one or two instances, I thought I could distinctly recognise the odour of hydrocyanic acid in the brain of dogs killed by that poison.

toxicologist, who has raised the following objections :— *

First.—That in animals poisoned by alcohol introduced into the stomach, he could never perceive the smell in any other part of the body.

Second.—That he has several times remarked, in the venous blood and in the brain of a fresh subject, a smell, which a *prepossessed* person might have confounded with that of alcohol, although no spirituous liquor had been taken before death.

Third.—That the statements have not been substantiated in the *only* way in which they admit of being substantiated, namely, by *chemical analysis*.

Now, of these objections, it is the last which has the most weight ; for it is, unquestionably, by chemical analysis alone, that conclusive evidence can be obtained. But the single chemical property of inflammability, which, in the case related by Dr. Cooke, the effused liquid was found to possess, is not sufficiently decisive. Dr. Ogston, however, appears to have contented himself with

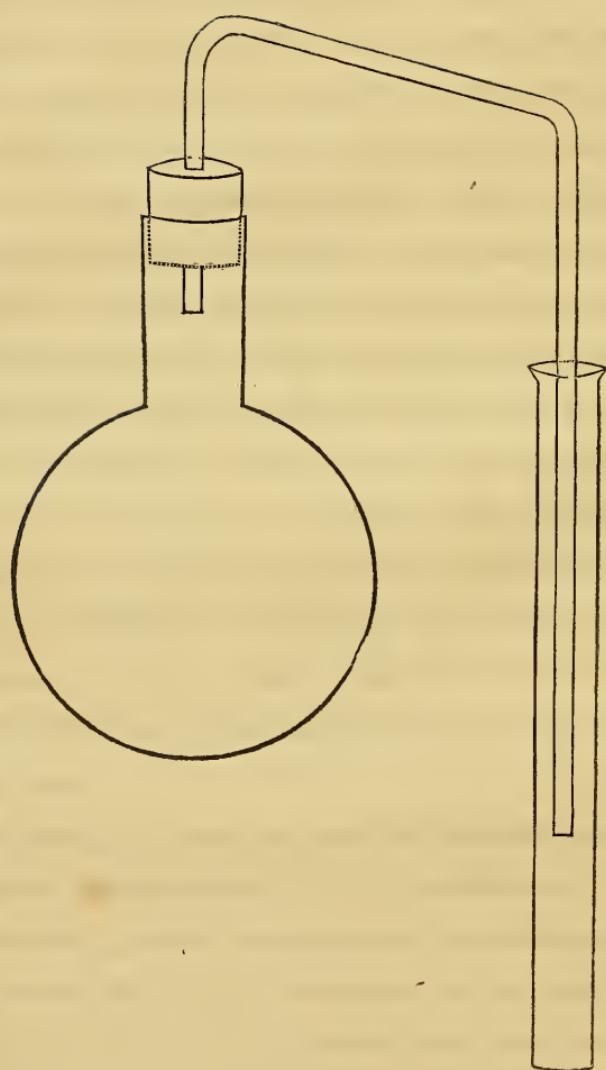
* Christison on Poisons, 3d ed. p. 853, et seq.

“ physical qualities,” and to have entirely disregarded all chemical proof. And it is to be regretted that the Doctor has not informed us what those “ physical qualities” are, which enabled him to pronounce, with so much certainty, that the four ounces of effused liquid, which he detected in the ventricles, consisted of pure alcohol. In the experiments which I am about to detail, I determined to rely solely upon chemical analysis, and, therefore, to conclude the presence of alcohol in those cases only, in which I should be enabled to procure an appreciable quantity of liquid, possessed of chemical properties sufficient to distinguish alcohol. The process which I adopted consists:—

Firstly, in the distillation of the matter to be examined.

Secondly, in the addition of sub-carbonate of potass to the product of such distillation.

Thirdly, in the examination by chemical tests of the liquid, which, if alcohol be present in appreciable quantity, will be separated and collected at the surface into a distinct stratum.



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This examination consists :—

Firstly, in determining whether such a supernatant stratum of liquid be combustible ; and

Secondly, in determining whether it be capable of dissolving camphor.

As the success of the operation, in great measure, depends upon the manipulation, it is necessary to give a detailed description of the apparatus employed, and of the precautions to be observed in conducting the process. Let us suppose, then, that it is required to examine some particular tissue, or, for example, the brain of a dog, in which we suspect alcohol. The entire brain, after being carefully removed, is cut into slices, which are transferred, as quickly as possible, into a small matrass ; a quantity of water sufficient to cover the whole organ thus sliced being next poured into the vessel, a bent glass tube, communicating with another receiving tube (as represented in the accompanying sketch), is adapted to the matrass, and distillation commenced over an Argand lamp. The distillation may also be effected in the chloride of calcium bath, without the addition of water to the matter

subjected to analysis. As soon as ebullition begins, the operator must attentively watch the matrass, and so regulate the heat as to prevent any portion of the froth that is generated from passing into the recipient. When about 3ss. has distilled over, the operation may be discontinued. The product is introduced into a small test tube, containing an adequate proportion of sub-carbonate of potass: the tube is then hermetically sealed, and, after brisk agitation, is allowed to remain at rest. If alcohol be present in appreciable quantity, it will be found collected into a stratum at the surface of the saturated solution of sub-carbonate of potass; from which, however, it will generally, if not always, be separated by some ash-coloured flocculi. On the contrary, if alcohol be not present in appreciable quantity, there will *generally* be no appearance of any supernatant stratum of liquid, although the flocculent matter may have accumulated at the surface as usual. Sometimes, however, as will be seen hereafter, the quantity of alcohol may be so minute as not to form any apparent stratum. It now remains to describe the manipulation

which is practised in investigating the properties of the supernatant stratum of liquid, eliminated, as above, by sub-carbonate of potass. The top of the tube being broken off, the fine extremity of a capillary pipette is carefully introduced just below the surface of the contained liquid, when, in obedience to the law of capillary attraction, a portion will rise into the pipette, which may be afterwards withdrawn : in this manner a sufficient quantity of the stratum may be readily obtained for examination. In order to prove whether it have the property of inflammability, the fine extremity of the pipette is to be placed near the edge of the flame of a lamp or candle, when the liquid, which is then to be gently propelled by blowing at the other extremity of the pipette, will, if alcohol, instantly take fire and burn with a blue flame ; but if a portion of the solution of sub-carbonate of potass should have been unintentionally taken up, which sometimes happens, especially when the supernatant stratum is very minute, it is scarcely necessary to add, that not the slightest indication of inflammability will be observed.

In order to make the application of the camphor test, a drop of the supernatant stratum is to be removed by means of the pipette, and deposited on a small fragment of camphor placed in the field of a simple microscope. If the liquid be alcohol, it will immediately be traversed in all directions by currents proceeding from the camphor, which will, in this case, be quickly dissolved; but the alcohol will rapidly evaporate, and leave a well-defined patch of camphor, consisting of little masses mixed with plumose crystallization. By the above methods of procedure, a single drop of alcohol will be found sufficient for many experiments.

EXPERIMENT I.

At 40 minutes after 6 A.M. precisely, I injected $\frac{3}{4}$ vi. of alcohol, sp. gr. 850° , through an elastic catheter, into the stomach of a large full-grown mongrel dog. Entire loss of voluntary power almost immediately succeeded; the animal fell prostrate on one side, and never afterwards moved a limb.

6^{h.} 45^{m.} Evacuation of feces took place, the

pupils were now contracted, the tongue pendulous from the mouth, and the respiration laborious.

6^h. 47^m. Laborious respiration continues, the pupils more contracted, and the muscles which move the lips in action; pulse 84, feeble and irregular.

6^h. 53^m. Respirations 26 per minute, laborious; inspirations full and forced, expirations rapid and loud.

6^h. 55^m. Evacuation of more and much darker feces. Pupils very much contracted; pulse 72.

7^h. Symptoms continue, and the conjunctiva appears dim and granular.

7^h. 3^m. Each expiration attended with a somewhat sonorous sound, which was soon changed into a kind of howling or moaning.

7^h. 10^m. A loud gurgling sound is heard on applying the stethoscope to the chest.

7^h. 15^m. Symptoms as before, but the moaning loud. The breath has still a strong alcoholic odour.

7^h. 25^m. Respirations 21 per minute.

7^h. 33^m. Respirations 18, more laborious. Moaning feeble. After each expiration, slight con-

vulsive action of the muscular parts in the immediate vicinity of the xiphoid appendix is observed.

7^h. 38^m. Eye-balls turned considerably downwards and inwards, and quite insensible when touched.

7^h. 41^m. Respirations 13. Moaning entirely subsided.

7^h. 45^m. Respirations 10, very feeble.

7^h. 49^m. Short convulsive respirations succeed at intervals of about 11 seconds—each inspiration is broken into three gasps.

7^h. 54^m. One very deep and laborious inspiration.

7^h. 55^m. An extremely feeble gasp terminated the respiratory function; at this time, also, the lower jaw ceased to move, although the muscles of the anterior parts of the neck were subsequently affected with occasional convulsive action, simulating feeble and defective attempts at deglutition.

7^h. 57^m. Heart still felt pulsating 65 per minute; but towards the end of the minute, during which the observation was taken, the intervals between the beats became much longer.

8^{h.} At this moment precisely, the last pulsation was felt.

Post-mortem, at 2 P.M., the same day.

Stiffening had taken place as usual. The blood was very imperfectly coagulated.

Head. Nothing abnormal was observed in the brain, or its investing membranes. There was no fluid in the ventricles, nor could any spirituous odour be detected.

Thorax. Lungs—the bronchi and air passages were filled throughout with a frothy serum-like liquid. The lining membrane was also very much injected in its whole extent.

Abdomen. Stomach—the contents smelt strongly of alcohol.* The mucous membrane was intensely injected, both in the intervals and on the summits of the rugæ. In the vicinity of the pylorus, the membrane was studded with minute, florid, and irregular spots, which were probably owing either to the enlargement of extremely small vessels, or else to actual extravasation.

* The stomach itself, also, after having been repeatedly washed, emitted a strong spirituous smell, which remained even on the following day.

About the cardiac extremity, there seemed to be a somewhat lymphy exudation.

Chemical examination. The brain, urine, fluid of the bronchi, contents of the stomach, and the blood taken from both ventricles of the heart, were severally introduced into matrasses, which were then tightly corked and left until the following morning, when, after the addition of a sufficient quantity of water to the brain and blood, distillation was effected. The products were poured into small glass tubes, containing an adequate quantity of sub-carbonate of potass, and the tubes hermetically sealed. Two days afterwards they were carefully examined. In that which contained the product of the brain, there floated on the saturated sub-carbonate solution, a thin stratum of very mobile liquid, about one line in depth, separated by a minute portion of light brown flocculi. The supernatant liquid being tested in the manner formerly described, was found instantly to dissolve camphor, and to burn with a blue flame. A similar examination of the tube, containing the product of the contents of the stomach, was attended with exactly the same

results; only, the supernatant stratum was much more considerable, being more than an inch in depth. There was no appearance of a supernatant stratum in any of the other tubes; nor on the application of a capillary pipette, could the slightest indication of the presence of alcohol be detected.

EXPERIMENT II.

At 6 minutes before 10, A.M. precisely, I injected $\frac{3}{4}$ ij. of alcohol, sp. gr. 850° , previously diluted with the same quantity of water, through an elastic catheter, into the stomach of a young mongrel bitch. No immediate effect was occasioned; but in 6 minutes from the completion of the injection, the animal began to stagger, and in 5 minutes more, appeared scarcely able to maintain the erect position: the pulse was then beating 140 per minute. At 15 minutes past 10, I repeated the injection of $\frac{3}{4}$ ij. of alcohol, diluted as before: the animal reeled and staggered about immediately afterwards.

10^{h.} 18^{m.} Pulse 160, full and regular. When the eyes are kept presented to the light, the

pupils are seen to dilate and contract alternately at short intervals. On calling her, she endeavours to rise and approach me, but is quite incapable of raising herself, or of standing when raised.

10^{h.} 26^{m.} Eye-lids and mouth perfectly closed. Pupils much contracted, and remain so, both when fully presented to the light, and when the eye-lids are nearly closed: there is no alternation of dilatation and contraction. The animal lies, as she has done almost ever since the last injection, prostrate on the left side.

10^{h.} 32^{m.} Direction of eyes fixed. Eye-lids affected with constant twinkling, both when completely approximated, and when partially opened. Hind extremities slightly drawn up with a tremulous movement at each inspiration.

10^{h.} 40^{m.} Eye-balls scarcely afford any indication of sensibility when touched. Movement of extremities on inspiration ceased.

10^{h.} 45^{m.} Respirations just 50 per minute.

10^{h.} 48^{m.} Mouth partly open, and tongue pendulous—a considerable quantity of limpid saliva has also escaped.

10^{h.} 50^{m.} Pulse about 180 (30 in 10 seconds.)

11^h. Eyes almost wide open, and pupils still contracted. Twinkling of eye-lids continues. Respiration difficult, and accompanied with a slight wheezing sound—abdominal muscles powerfully in action.

11^h. 10^m. I observe distinctly, feeble convulsive tremor of the lips.

11^h. 20^m. Expiration attended with a peculiar and faint shrill sound, resembling that produced by a reed-whistle—change of posture causes no alteration either in its nature or intensity. During the experiment, I have frequently observed convulsive action of the genio-hyoid, or some other adjacent muscle.

I now opened the right jugular vein, in order to procure a sufficient quantity of blood for analysis; a copious stream, perfectly fluid and of remarkably florid colour, instantly flowed from the orifice. The symptoms underwent no appreciable change. The vessel being secured by a ligature, I administered a dose of prussic acid, of Scheele's strength, amply sufficient, as I concluded, to destroy life; instant dilatation of the pupils succeeded, and death apparently super-

vened in a few minutes : the heart's action, as well as the respiratory function had ceased, for no pulsation could be felt on placing the hand on the chest. I then lifted the animal from the floor, and placed her on the bench, with the intention of immediately opening the head ; but, suddenly, to my great surprise, she took a deep inspiration, which was quickly followed by other similar gasps.* I repeated the dose of acid, which completely extinguished life. It is worthy of remark,

* This resuscitation was probably occasioned by the loss of blood. In Dr. Cormack's Prize Thesis, "On the presence of Air in the Organs of Circulation," an experiment is recorded in illustration of the "beneficial effects of copious depletion, when a poisonous dose of prussic acid has been administered. A free opening was made in the jugular vein of an ordinary sized pointer dog, and haemorrhage prevented by means of pressure. A dose of prussic acid was then administered, of such strength as to contain about a drop of the real acid. The animal became almost immediately affected, uttered some faint cries, in twenty seconds fell down, and lay for a few seconds motionless on the floor. He then began to struggle as if in the agonies of death ; but the vein broke out, and the blood flowed in a rapid and copious stream. Immediately the dog shewed signs of returning vigour. He raised his head, then in a few seconds looked around him, and his eyes, which were formerly dim and suffused, regained their natural lustre. From this time he rapidly recovered, and began to lick up his own blood," p. 38, 39.

that there was no tetanic spasm, the hinder extremities only being feebly extended.

Post-mortem, immediately after the conclusion of the experiment. The muscles were excited to powerful contraction, when irritated by the scalpel. Stiffening subsequently took place, and the blood coagulated firmly.

Head. The brain did not present any abnormal appearance; the *sinus*, however, were distended with florid blood, which gushed out on removing the skull-cap. A very small quantity of clear liquid, amounting certainly to not more than a few drops, was contained in the ventricles. I thought I could now recognize somewhat of an alcoholic odour to proceed from the organ, the ventricles of which were at this time exposed.

Thorax. Lungs collapsed, natural. Both ventricles of the heart contained dark clots.

Abdomen. Liver, spleen, pancreas, and kidneys, healthy. The gall-bladder was distended with bile, which seemed, if any thing, rather more fluid than usual. The urinary bladder healthy and distended with urine. Stomach—occupied a

considerable portion of the abdominal cavity, being filled with a large quantity of fluid, exhaling a strong spirituous smell, and mixed with much pultaceous matter, consisting principally of semi-digested bread. The marks of inflammatory action were confined to the great cul-de-sac. The whole internal surface of this part of the viscus was covered with a thick coat of tenacious and viscid matter, and presented a brownish lake injection, which, on the removal of the superjacent exudation, acquired a redder tint. The injection was not uniform, but consisted of minute florid lake, or cherry-coloured reticulations, interspersed with small and similarly coloured patches ; it was most intense in the intervals of the rugæ, towards the right boundary of the great cul-de-sac. The membrane of the remaining portion of the organ seemed perfectly healthy ; it had the pale yellowish red tint, which I have usually observed in dogs, killed when the process of digestion, owing to a deficient supply of nutriment, has not been in vigorous operation for some time previous. The intestines were generally contracted and nearly void ; containing only a small quan-

tity of bilious matter, adherent to the villous coat. I did not observe any sign of inflammation, or other morbid appearance.

Chemical examination. The brain and the blood from the jugular vein, the urine, the bile, and the contents of the stomach, were severally subjected to analysis: and in every instance, an appreciable quantity of alcohol was obtained, as proved both by the test of dissolving camphor, and that of inflammability. Before distillation, the necessary quantity of water was added to the brain and the blood; but no addition was made to the urine, bile, or contents of the stomach. In every analysis, I have invariably taken care to mix a little water with the blood; as without this precaution, it would be scarcely possible to conduct the distillation over a naked lamp; for the albumen which, on the application of heat, quickly coagulates, would soon adhere firmly to the bottom of the matrass, and would consequently be very liable to break it.

In exemplification of what has been formerly stated, I may here remark that in the test tube, which contained the product of the blood, there

was no discernible supernatant stratum ; although by careful application of the pipette, as before described, I procured amply sufficient alcohol for the determination of its properties. There was, however, a much greater accumulation of flocculent matter than usual, which may have probably concealed the stratum of alcohol.*

EXPERIMENT III.

At 15 minutes past 12, at noon, I injected $\frac{3}{4}$ iv. of alcohol, sp. gr. 850° , into the stomach of an old spaniel dog. With the exception of some crying during the introduction of the catheter, the animal did not evince any particular symptom of uneasiness : he walked about the apartment in a somewhat restless manner ; but, in five minutes from the completion of the injection, he faltered and reeled, and was scarcely able to stand, the hinder extremities especially appearing to fail. At this time, also, he breathed hurriedly, with the tongue protruded, as is usual with dogs when

* Indeed the quantity of this matter was so great, as to prevent the subjacent liquid from descending, when the tube was inverted.

running. At 26 minutes past 12, he vomited a small quantity of very frothy liquid, exhaling a strong spirituous odour; and at 35 minutes past 12, vomiting of a little bilious matter, having a strong alcoholic smell, again occurred. There was now some whining, attended with apparently defective attempts at barking: the limbs and body were powerless, the respiration was difficult, and accompanied with a somewhat stertorous sound, and the pupils were dilated. At 40 minutes past 12, vomiting of some bilious matter again occurred. At 43 minutes past, I repeated the injection of $\frac{3}{4}$ iv. of the same alcohol: vomiting of frothy spirituous liquid succeeded. The animal lay upon the right side, with the limbs forcibly extended, and the tongue protruded—the respiration was hurried, difficult, and abdominal, and the eye-balls, when touched, afforded but the slightest indication of sensibility. At 6 minutes before 1, the limbs had become flexible and powerless. At 8 minutes after 1, I again injected $\frac{3}{4}$ ij. of the same alcohol, which produced no immediate and sensible alteration. The respiration, however, soon became extremely feeble,

and ceased at 15 minutes and a few seconds after 1; but at 23 minutes after 1, there were two or three feeble gasps, and, subsequently, slight convulsive action of the muscles of the neck. The conjunctiva had now a dim and streaked appearance. At 15 minutes past 1, the heart's action, which a short time before was slow and regular, was very slow, intermitting, and irregular; from this period, the pulsations became gradually weaker, and the intervals increased to several seconds. I observed the last pulsation, extremely feeble, at 25 minutes past 1. I could not detect the pulse in the thigh for some time previous.

Post-mortem, at half past 5 the same evening. The animal lay stretched on one side, with the limbs extended, the jaws closed, and the tongue protruded between the teeth. The nostrils were moistened with a little bloody mucus. Stiffening took place, and the blood coagulated, but not firmly. I proceeded to remove the brain, which I did with great care. The mouth was first well enveloped in a clean cloth, in order to provide against the possibility of fallacy arising from the accidental presence of alcohol on the lips. I was

unable to detect any morbid appearance, either in the brain itself, or its investing membranes. The ventricles were examined after the removal of the organ, and only a few drops of liquid, sufficient merely to lubricate their surface, were found. I could not perceive any spirituous smell before the dura-mater was detached ; but, subsequently, during the process of slicing, I thought I could distinctly recognise the odour of alcohol.

Thorax. The lungs were somewhat congested ; but the lining membrane of the bronchi and air-passages was natural.

Abdomen. The solid viscera seemed healthy. The gall-bladder contained but little bile. Stomach—the contents consisted of a small quantity of liquid, tinged with blood, and emitting a spirituous, though not powerful, smell. The lining membrane throughout, as well as that of the lower part of the æsophagus, was considerably indurated, rendered friable, and also much corrugated ; so that it could be easily scraped off, or detached with the finger nail. The whole surface of the membrane presented an uniform dirty brown tint (very similar to that of liver when

boiled), except in the intervals of some of the rugæ, where it was much injected. The coats of the stomach had a spirituous smell, which, after repeated washing, soaking in water, and free exposure to the air for several hours, was still retained. The intestines were generally contracted and void, as the animal had refused food for two or three days previous to his death.

Chemical examination. The brain, bile, urine, and contents of the stomach, were analyzed ; and from all, except the urine, alcohol was procured. In the tube, containing the product of the brain, the supernatant stratum was about $\frac{1}{4}$ inch in depth.

My attention having on a former occasion been arrested by the strong smell of alcohol, which the coats of the stomach preserved, even after repeated washing, I proposed in this instance, to have recourse to chemical analysis for confirmation ; and also to determine whether the spirituous smell would remain, or whether alcohol could be detected, after exposure and soaking of longer continuance. Two days after the experiment, I again examined the stomach, and found that it

still possessed a strong spirituous smell. I then cut one half into narrow slips, which I introduced into a matrass, containing sufficient water to cover them: distillation was commenced, and the process continued as usual. On agitation with sub-carbonate of potass, an abundant supernatant stratum appeared, which instantly dissolved camphor, and burned with a blue flame. The other half of the stomach was again soaked in water, and a stream of water, also, issuing with great velocity from a tap, was, for some time, directed upon it; after which, it was left freely exposed to the atmosphere until 12, A.M. the following day, when even at that time, it emitted a faint odour of spirits. It was now cut into narrow slips, which were treated in precisely the same manner as in the former case. A very sensible quantity of alcohol, forming a stratum about $\frac{1}{4}$ inch in depth, was obtained in the usual way. These experiments are curious, as they shew with what pertinacity, even a liquid like alcohol, which evaporates with great facility, may adhere to, or be, as it were, combined with organic membranes. They may also possibly be rendered available in a medico-legal point of view.

EXPERIMENT IV.

At 4^{h.} 35^{m.} P.M. precisely, I injected ȝij. of alcohol, sp. gr. 840^o, diluted with the same quantity of water, into the stomach of a terrier dog. No immediate effect was occasioned.

4^{h.} 54^{m.} He vomited a small quantity of clear liquid.

4^{h.} 59^{m.} He could scarcely stand, and staggered about.

5^{h.} 18^{m.} I injected ȝiv. of pure alcohol of the same density.

5^{h.} 23^{m.} Pulse extremely rapid, more than 160, full and bounding.

5^{h.} 53^{m.} I injected another ounce of the same alcohol, diluted with an equal quantity of water.

6^{h.} 6^{m.} Cold water injected into the ears produces no effect—constant twitching of hinder, and right fore extremities, and also of muscular parts at the angle of the mouth—when the legs are forcibly held, the twitching still continues—lies prostrate on the right side—heart's action continues extremely rapid—movements of extremities as in running.

6^{h.} 39^{m.} Lies motionless and quite insensible; pulse too rapid to be counted—stertor—tongue partially protruded—conjunctiva injected—eyeballs fixed and nearly insensible—pupils much dilated.

6^{h.} 49^{m.} I destroyed him with prussic acid—there was merely slight extension of back and extremities.

Post-mortem. The head was opened about $\frac{3}{4}$ of an hour after death. A decided smell of alcohol was immediately perceived. The vessels of the pia-mater were minutely injected. The hemispheres were sliced off *in situ*, but no appreciable effusion was found in the ventricles. The stomach contained no solid ingesta, but was distended with spirituous liquid. It was left exposed to the air, being merely covered by a plate; and eight days afterwards, I distinctly remarked a slight spirituous odour.

Chemical examination. In the evening, the brain was subjected to distillation in the chloride of calcium bath, without the addition of water. A sensible quantity of alcohol was obtained in the usual manner. A considerable portion of

the liver was treated in precisely the same way, and a supernatant stratum of alcohol $\frac{1}{2}$ inch in depth was obtained.

Four experiments have now been related, in which, after injecting a considerable quantity of alcohol into the stomach, a portion of the intoxicating liquid was extracted from the brain; although no effusion was found in the ventricles, as in the cases of Dr. Ogston and Mr. Carlisle. In three of the experiments, I thought I could distinctly recognise the odour of alcohol in the brain; but, though I was certainly not prepossessed by any prejudice, I may have been deceived; for the distinguished toxicologist, to whom I have before alluded, has stated, that he never could perceive a spirituous smell in any other part but the stomach of animals, poisoned by the introduction of alcohol into that viscus. The subsequent confirmation, however, by chemical analysis, is at variance with the idea of my having been deceived by the sense of smell.*

* Vide Cyclop. of Pract. Medicine, Art. "Spontaneous Combustion," by Apjohn. "That the bodies of drunkards may become, as it were, soaked with alcohol, seems fully established by

Although the process, which I have adopted for the detection of alcohol, may appear sufficiently decisive, yet, when we consider the nature and composition of alcohol, and the manner in which it is generated, nothing absurd, or even improbable, is involved in the supposition, that a small quantity might be produced during the process of distilling, &c. I, therefore, resolved to prove the correctness of the induction by negative evidence. To this end, I selected two large, full-grown, and healthy dogs, one of which I destroyed by prussic acid, and the other by strychnia: the brains, and blood from the *venæ cavæ* of each, were subjected to analysis, and the operations conducted with as much care and attention as I could possibly bestow. However, not the slightest indication of the presence of alcohol was detected. The bile and urine also (what little urine there was) of the dog killed by strychnia, were

observation. Thus, Breschet found the different tissues of the bodies of criminals opened shortly after their execution, to evolve a strong smell of *eau-de-vie*; and a similar observation has been made by Duméril and Cuvier, upon the body of a labourer, at the Garden of Plants, who had died from the effects of a large quantity of wine, which he had drunk for a wager."

treated in precisely the same manner, with precisely the same result. Thus I have endeavoured to obviate any objection, which might have been raised to the sufficiency of the tests employed.

It will be observed, that in the preceding experiments, the animals lived but a short time, comparatively speaking, after the exhibition of the alcohol, and that no appreciable effusion was found in the ventricles. I shall now detail an experiment, in which the animal lingered for many hours in a state of profound coma, and in which effusion was found in the ventricles.

EXPERIMENT V.

At 4 minutes before 10, A.M. precisely, I injected 3ij. of alcohol, sp. gr. 850°, diluted with an equal quantity of water, into the stomach of a mongrel bitch. At 10, after sitting for sometime, she fell on her belly; symptoms of uneasiness were also manifested by the twinkling of the eyelids, and movement of the head from one side to the other: she made no attempt to approach me when I uttered signs of caress, although she had done so a little before. In four minutes more,

she in vain endeavoured to rise and stand ; voluntary power seemed to be most deficient in the hinder extremities.

At 10^{h.} 7^{m.} however, she again attempted to walk, and with faltering, succeeded for a few steps ; pulse 174, of moderate strength.

10^{h.} 14^{m.} I repeated the injection of ȝij. of alcohol, diluted with ȝij. of water, and no resistance was offered to the introduction of the catheter. She staggered two or three yards immediately afterwards, and then lay down with the limbs slightly drawn up.

10^{h.} 20^{m.} Pulse exceedingly rapid. Eye-lids half closed. On inspiration, tremulous movement of limbs, which extends more or less to the whole body. Inspiration very long in comparison with expiration, of which the duration is short.

10^{h.} 27^{m.} Champing began, and continued incessantly for several minutes, the animal, at the same time, constantly licking the sides of the mouth ; but voluntary power over the muscles of the tongue appeared to be impaired, as the organ, after each protrusion, was but partially drawn into the mouth.

10^{h.} 30^{m.} Pulse 180 (30 in 10 seconds.) Respiration, at intervals, attended with stertor.

10^{h.} 34^{m.} Eye-balls affected with oscillating movement from before backwards. Tremulous movement of limbs ceased. Body nearly devoid of power.

10^{h.} 39^{m.} I again repeated injection of ȝij. of alcohol diluted with ȝij. of water. The eye-balls became fixed and directed upwards immediately afterwards; but at 10^{h.} 40^{m.} they were again affected with oscillating movement. The animal lay upon the right side, perfectly powerless and insensible: the pupils were dilated, as they had been for some time previous—the tongue protruded, the conjunctiva injected, and the respiration accompanied with slight stertor.

10^{h.} 45^{m.} Pulse 150, feeble.

10^{h.} 59^{m.} Pupils, which before were dilated, had now become much contracted—eye-balls quite fixed, and directed downwards; pulse 138; breath still strongly alcoholic.

11^{h.} 5^{m.} Pupils intensely contracted, and perfectly insensible when touched.

11^{h.} 15^{m.} Pulse 108, very feeble.

11^h. 18^m. Respirations 26 per minute.

11^h. 46^m. Pulse 94. Respirations 25, extremely feeble, insomuch that the chest appears scarcely to move.

1^h. 30^m. Conjunctiva now dim and streaked—surface of the body cold ; pulse 76, feeble. Respirations 32. Pupils continue intensely contracted.

2^h. 28^m. As before ; pulse 60, very weak and irregular. Respirations 22, very indistinctly performed.

2^h. 49^m. Pulse in thigh extremely feeble. Heart's action 60, irregular. Respirations 24, very feeble and the intervals irregular.

3^h. 50^m. Pulse, as before, 47.

4^h. 30^m. Heart's action 40. Respirations 20.

5^h. 30^m. As before. Pulse 40. Respirations 25. Surface very cold. There is continual convulsive tremulous motion of the muscles of the lips, extending also to the neck.

7^h. 2^m. Pulse in thigh scarcely perceptible. Heart's action irregular, 36. Respirations 19. Chest much distended.

7^h. 56^m. Pulse in thigh imperceptible. Heart's

action very weak, 50. Respirations 14 or 15, only just perceptible.

8^{h.} 40^{m.} Heart's action scarcely to be felt, 39. Respirations as before, 10.

9^{h.} 17^{m.} Heart's action as before. Respirations 7.

9^{h.} 31^{m.} Heart's action almost imperceptible. Respirations about 12. There is also occasional and very slight convulsive twitching at the angle of the mouth, and in the adjacent muscles of the neck, simulating, as I have noticed in a former experiment, defective attempts at deglutition. The tongue, also, on separating the jaws, is observed to be affected with constant convulsive tremor.

9^{h.} 46^{m.} Respiration entirely ceased, and action of the heart imperceptible.

Post-mortem, two days afterwards, Sunday being allowed to intervene. Stiffening took place, and the blood coagulated. The tongue and mouth were very livid.

Head. The skull-cap was cautiously removed, so as not to injure the dura-mater. The longitudinal sinus contained coagulated dark blood. I

carefully examined the arachnoid, but could not discover subjacent effusion. The pia-mater was minutely injected : the larger vessels were turgid with dark blood. I now carefully sliced off the hemispheres *in situ*, in order to arrive at the lateral ventricles. In the right ventricle, I observed only a little serum-like liquid ; but on cutting into the left, similar liquid immediately flowed out, and, with a capillary pipette, I was enabled to procure an appreciable quantity. It is worthy of remark, that the animal had lain on the right side, and that it was placed on the same side after death. I did not detect any alcoholic smell in this instance.

Chest. There was no trace of liquid in the pericardium ; nor could I detect the slightest odour of alcohol.* The *right* auricle and ventricle were distended with firmly coagulated black blood, which became florid on exposure to the atmosphere. The *left* auricle and ventricle, and

* Vide Christison on Poisons," 3d ed. p. 853, where a spirituous odour is reported to have been observed in the pericardium, after rapid poisoning with whiskey. Vide also "Lancet," v. 1. 1836-37, p. 271, where æther is reported to have been smelt in the pericardium.

also the thoracic aorta, contained similar coagulated blood. The vessels going to and from the lungs, and the *venæ cavæ*, were distended with dark blood. The right lung was the darkest, owing probably to the position of the body. The trachea, bronchi, and air-passages, contained much frothy and colourless mucus (?), which, I thought, emitted a faint spirituous smell.

Abdomen. I could not detect any thing abnormal in the liver, spleen, pancreas, or kidneys. The gall-bladder contained a considerable quantity of bile. Stomach—it was much distended with food. The external or peritoneal surface was beautifully reticulated with injected minute vessels. The mucous membrane had generally a brownish red colour, which varied from a light plum tint in the vicinity of the pylorus, to a pale flesh colour near the great cul-de-sac. Near the cardia existed a deep brownish lake, irregular, and marbled patch, about $\frac{3}{4}$ of an inch square, together with other similar but smaller patches. Along the great curvature several of the rugæ, and some of the intervals also, were veined with crimson. In other parts of the organ, especially

near the cardiac extremity, there were several clusters of well-defined spots (probably melanotic), varying in size from a pin's head to a pea, or larger, together with small irregular patches of a black colour, surrounded by less intense, but similarly coloured areolæ. The intestines were rather contracted than otherwise, except the rectum, in which were feces. They contained some gaseous matter, and presented externally a darkish grey hue. The mucous membrane appeared healthy, except at about four feet distance from the pylorus, where, for a considerable extent, it had a dull brownish red colour. I did not observe any sign of extravasation.

Chemical examination. The liquid effused into the left ventricle of the brain, neither dissolved camphor, nor shewed the least sign of inflammability, nor emitted the slightest odour of alcohol. I then endeavoured to subject it to analysis in the usual manner ; for which purpose, I employed, as the apparatus for distillation, a small bent tube, one end of which was sealed, and the other drawn out into a capillary beak, which was received into another small tube, containing sub-carbonate of

potass. On the application of heat, however, a portion, or rather the greater part of the liquid, was suddenly propelled into the receiving tube. I then removed the latter, and allowed it to stand at rest for some minutes ; after which, I thought I could observe a supernatant stratum. But on more careful examination, I found that no such separation had taken place. With a capillary pipette introduced just below the surface, I removed a few drops ; but they neither burned, nor dissolved camphor. Owing to the accident above-mentioned, the experiment can only be regarded as decisive in so far as it shews, that if the effused liquid contained any alcohol whatever, it must have been in very small proportion ; because none was eliminated by sub-carbonate of potass.

With regard to the brain, which was treated in the usual way, I am not warranted in pronouncing with certainty, concerning the presence of alcohol. I must state, that, on the evening of distillation, a supernatant stratum instantly appeared, on agitating the product in a test-tube with sub-carbonate of potass ; but, unfortunately, I did not immediately proceed to examine the

liquid so separated : I left the tube apparently hermetically sealed. On the following day, also, I well recollect observing the same stratum. But in two or three days afterwards, when I took up the tube, in order to make the application of the tests, I found, to my surprise, that the stratum was no longer visible. This led me carefully to inspect the upper extremity of the tube, and I found that it had not been hermetically sealed ; so that the stratum must have evaporated. I am, therefore, inclined to think, that little reasonable doubt can be entertained of the presence of alcohol in the brain under consideration ; for in every instance, where I have seen a supernatant stratum separated by sub-carbonate of potass, subsequent analysis has borne testimony to its alcoholic nature.

No trace of alcohol was detected in the blood of the venæ cavæ and heart ; but a very sensible quantity was extracted from the bile and contents of the stomach. The urine was not examined, as the quantity procured was too inconsiderable.

Now it will be seen, that no result has yet been advanced in direct confirmation of the statements

of Dr. Ogston and others ; on the contrary, it would appear from the last experiment, that even where effusion did take place to a considerable extent, no alcohol could be detected in the liquid effused ; although the substance of the brain yielded an appreciable quantity on analysis. Yet I must in candour confess, that as the actual quantity of liquid effused was, comparatively speaking, trifling, for it did not amount to 3ss., it does not appear to me satisfactorily proved, that alcohol was not present in the effusion. It is true, that not a drop could be obtained on agitation with sub-carbonate of potass ; but it must be remembered, that the process of distillation had been omitted, or what is equivalent, that the attempt at distillation had failed. And in an analysis, which I recently performed, I found that no supernatant stratum appeared on agitating sub-carbonate of potass with the liquid, removed, by means of the pump, from the stomach of a man, who was in a comatose state from excessive drinking ; although this liquid smelt strongly of rum, and, by the usual method of analysis, furnished a copious stratum of alcohol. One

thing, however, is certain; namely, that the liquid effused neither “possessed *all* the *physical*,” nor all the *chemical*, properties of alcohol; for, in the first place, it had no spirituous smell, and in the second, it was neither combustible, nor capable of dissolving camphor. Now what conclusion can be drawn from these experiments? Are they to be regarded in favour of, or at variance with, the experience of Dr. Ogston and others? On the one hand, the circumstance of alcohol being detected in the substance of the brains of dogs, may be legitimately adduced as presumptive evidence in support of the correctness of the observations respecting its existence in the ventricles of the brains of men, after poisoning by spirituous liquor. On the other hand, the experiment last detailed has a directly opposite tendency; and this experiment is supported by another, to be afterwards introduced, in which, by the most delicate analysis, I was unable to separate any alcohol from the liquid effused into the ventricles after the injection of alcohol into the jugular vein, although I obtained a considerable quantity from the substance of the brain. I acknowledge

that I do not consider the data sufficient to enable me to arrive at a perfectly satisfactory conclusion ; yet I am certainly inclined to assign the least weight to the objectionable argument.

It is with much satisfaction that I now introduce an analysis of the human brain, in confirmation of the preceding experiments ; and it is with much greater satisfaction that I can also add, that Dr. Christison has confirmed this analysis. I am indebted to the kindness of my friend Dr. Duncan for a portion of the brain of an unfortunate man, who killed himself by an excessive dose of rum. I insert the history of the case, in Dr. Duncan's own words :—

“ Mr. C. æt. 24, was a person of very eccentric character, but of temperate habits ; so much so, that during the period of 10 months which he had passed in the same lodging, he had only once been seen under the influence of wine. On the evening of the 8th of April (1838), he returned to his lodging about 11 o'clock in a state of perfect sobriety ; and having finished his supper, which consisted of cheese and $\frac{3}{4}$ of a bottle of ale, he retired to his bed-room, giving the usual instruc-

tions to his landlady not to disturb him next day (Sunday), which he always passed in bed. In the afternoon they knocked at his room door, but as he did not answer, they thought he was asleep. In the evening they again knocked, but still no answer was given; and next morning becoming alarmed, they forced the door, when they found him lying dead on the floor with his night shirt on, although he had evidently never been in bed.

“ The body was examined on the Tuesday morning. The attitude in which he was found was an easy one: the inferior extremities were extended, the right arm was under him, whilst the left arm was folded across the chest. The limbs were extremely rigid, and required much force to flex them. The skin of the thighs was much puckered (*cutis anserina*). The eye-lids were half closed. There was some blood on the right ear from a slight abrasion, and on removing the coagulum, a little more in a fluid state exuded. The feet and hands were livid.

“ *Chest.* The lungs were healthy, but gorged posteriorly with dark-coloured blood. The bronchial membrane was of its natural colour, and

the air-tubes contained a small quantity of frothy fluid. There was some slight serous effusion under the mucous membrane of the glottis, but not sufficient to impede respiration.

“ The heart was natural in size, but the right ventricle and auricle with the vena cava ascendens and descendens, were much distended with dark-coloured fluid blood. The left side and aorta were perfectly empty.

“ *Abdomen.* The stomach contained about 3vj. of a darkish fluid, which smelt strongly of rum, or rum and sugar; its lining membrane was natural in colour, except in the neighbourhood of the cardiac orifice, where it was somewhat injected. The liver was healthy in appearance. The gall-bladder was large and distended with light-coloured bile. Intestinal canal healthy. Urinary bladder distended.

“ *Head.* The vessels on the surface of the brain were unusually gorged with dark fluid blood. There was no effusion under the arachnoid, nor at the base of the brain. The cerebral substance was firm, but when cut into, presented more than the usual number of bloody points. There

was about 3j. of fluid in each ventricle. The brain generally smelt strongly of the contents of the stomach.

“On the table in his bed-room was a bottle, containing about a tea spoonful of rum. This the landlady knew was full late on the Saturday night ; so that it was certain he had drunk it all, and probably by *putting the bottle to his mouth*, as there was no glass in the room.”

At my request, Dr. Duncan was kind enough to re-open the head (as I was not present at the examination), in order to obtain for me a portion of the brain. I received it on the 12th, in a stoppered phial. I thought I could distinctly recognise the peculiar odour of rum. In the afternoon of the same day, I subjected part of the brain (about equal in bulk to the brain of a dog) to analysis in the usual manner, having previously added a small quantity of water. Every possible precaution was observed. I distilled over about $\frac{2}{3}$ of a dram. On agitation with sub-carbonate of potass in a small test tube, a supernatant stratum, $\frac{1}{4}$ inch in depth, instantly appeared, and was separated from the subjacent solution by some flocculent

matter. The liquid composing this stratum, colourless and very mobile, instantly dissolved camphor, and burned with a blue flame. Dr. Christison examined the remaining portion of the brain. It was subjected to distillation in a matrass, without the addition of water, heat being applied by means of the oil bath. The product was re-distilled from sub-carbonate of potass, and the portion which first passed over into the recipient was found to be inflammable. A piece of asbestos was employed instead of a capillary pipette, in order to determine the inflammability.

Through the kindness of Dr. Christison, I have also been enabled to examine the brain of another man, who recently died in the Royal Infirmary of this city, from the remote effects of alcoholic liquor. Although I did not anticipate the least chance of success, as the life of the man was protracted for several days, and as death was occasioned by acute meningitis, yet as Dr. Christison suggested, it was important to establish the absence of alcohol. That alcohol must have been present in the brain, the experiments already detailed entitle us to conclude; and hence the *pro-*



bability, or rather the *possibility*, that the phrenitic inflammation was produced by the contact of irritating alcoholic liquor with the cerebral substance. From a careful review of the symptoms recorded, the history of the case will immediately be seen to resemble, in many particulars, the case of Torrington, which is introduced into a subsequent part of this Thesis :—

“ Hugh Wilson, aet. 40, a mason. Admitted 16th April, 1838, at 12 o’clock at noon. It was ascertained that he was an habitual drunkard, and that he had been daily intoxicated during the last three weeks. He was found, on the morning before admission, lying in a state of insensibility in a wine cellar in the suburbs, into which he had broken for the purpose of gratifying his propensity to indulge in intoxicating liquors. A considerable quantity of port wine and cherry whiskey had disappeared from the cellar ; but it was not ascertained how much had been actually swallowed by this individual. About 2, p.m. his insensibility continuing, a medical man drew off by means of the stomach pump about a quart of red liquor, having a strong odour of spirits. About

9 o'clock, he had recovered sufficiently to walk to the police office, which was distant about a mile. During the night he became restless and disposed to violence; and this continuing the next day, he was conveyed here. On his arrival he could walk, and asked for drink, but did not answer questions. Immediately after admission he was seized with a violent convulsive paroxysm, attended with coma; it lasted for six minutes, during which period the face was flushed, the pulse frequent, and the pupils were dilated. For some minutes longer he remained incapable of articulating, and apparently unable to understand questions, although his limbs moved in obedience to external impressions. At 1 o'clock (an hour after admission) he was found more sensible, and lay quiet; he vomited several times, and answered simple questions. On admission the breath had no alcoholic odour. There was a contusion over the left eye; the cause of which could not be ascertained. A purgative draught was ordered, the head was shaved, and cold lotion applied to the scalp. At 3, p.m. he had constant vomiting of ingesta; he conversed intelligently, but looked

confused. Two grains of opium were ordered. At 8 o'clock vomiting had ceased, and he lay quiet.

“ On the 17th (day after admission) it is reported that he had been disturbed by a neighbouring patient during the night. He has a tendency to wander and leave his bed, but answers simple questions correctly. Pulse 120, of moderate strength. Copious evacuation passed in bed without notice. Was ordered gtts. xl. of sedative solution (*muriate of morphia*), to be repeated at bed time.

“ On the 18th, it is reported that he had two draughts of the sedative solution. Had constant delirium, with tendency to violence. Pulse 110, full and soft. Answers some questions correctly. No return of vomiting. Was ordered dram doses of the sedative solution every alternate hour, until its effects were produced. After the third dose he became more quiet, and occasionally slept. Is easily roused, and answers simple questions intelligently; but rambling delirium continues. Pulse 120, of moderate strength. On the morning of the 19th he was found comatose, and died at 7, A.M.

" *Sectio.* April 20th, 1, P.M.

" *Head.* A considerable quantity of effused blood was found in the cellular tissue over the left orbital ridge, extending across the nasal bones. No marks of fracture or other injury could be observed on the bones. Ten drams of serum were collected by a pipette from the cavity of the arachnoid within the cranium. During this time the head was propped up by a block ; so that little, if any, of this fluid could have flowed from the spinal canal. Considerable effusion of serum under the arachnoid, stretching that membrane across the convolutions at the anterior part of the brain, as well as at the depending portions. The brain when sliced presented a moderate number of red points ; and the difference between the colour of the grey and white matters was distinct. The lateral ventricles contained 3ss. of clear serum. On the inferior surface of each anterior lobe existed a deep yellow patch, about $\frac{1}{4}$ of an inch in length, and nearly $\frac{1}{2}$ an inch in breadth. Each of these patches commenced at the olfactory bulb, and extended posteriorly in the exact line of the groove for lodging the olfactory nerve. This

alteration of colour was confined to the surface of the brain above, and did not extend above 2 lines into the interior. The portion of the brain thus altered was quite soft. The line of demarcation between the healthy and diseased portions was distinct and well defined. Part of the yellow softened matter adhered by cellular-like adhesions to the dura-mater ; but this membrane itself had suffered no apparent change. The olfactory bulbs had undergone this yellow softening ; but the rest of the nerves appeared unaltered. On stripping off the dura-mater, the ethmoidal process of the sphenoid bone decidedly projected above the level of the ethmoid bone ; but there was no evidence that this was the result of external violence. A yellow patch, about an inch in length, and $\frac{1}{4}$ of an inch in breadth, and similar in every other respect to the two already described, except that it appeared deeper at one part, was found on the posterior and lateral part of the middle lobe of the left hemisphere. The bone at this part was unchanged. The rest of the brain was everywhere of the usual consistence, and the arteries were healthy.

“ *Abdomen.* The stomach was rather small, and presented numerous folds on its inner surface. The splenic extremity was deeply tinged with bile. At the anterior and lower part of the pyloric extremity, a portion of the mucous surface (about 2 inches in length, and $1\frac{1}{2}$ in breadth) presented a number of bright red spots, the intervening portions being of their natural colour. The mucous membrane was of a reddish colour in several places ; but it was neither diminished in thickness nor softened at any part. With the exception of three small circumscribed portions of a bright red colour, separated from each other by considerable intervals, the mucous surface of the duodenum was perfectly natural. Nothing abnormal was found in the jejunum and ileum, except a small elevation (apparently an enlarged solitary gland), with an ulceration on its summit. The kidneys were healthy. The liver contained a number of minute yellowish granules disseminated through it. The gall-bladder was distended with bile.

“ *Chest.* The heart large, but healthy. No decided enlargement of the thoracic aorta ; but its inner surface presented a tuberculated appear-

ance, proceeding in some places to the deposition of calcareous matter. Numerous dark-coloured and miliary tubercles scattered over the whole surface of the right lung. The upper lobe of this lung adhered strongly to the costal pleura. A considerable portion of this lobe of the lung was quite dense, from the deposition of dark-coloured tubercles, intermixed in some places with a yellow soft matter.” *

No alcoholic odour was detected in the brain, or in any other part of the body.

Chemical examination, in the afternoon of the same day. The serous effusion, substance of the brain, and bile, were subjected to analysis.

The effusion from the ventricles was very carefully treated in the usual way, but not the slightest trace of alcohol was obtained.

Of the effusion from the cavity of the arachnoid, 3 ss. was mixed with an excess of sub-carbonate of potass, and then distilled. The first portion which came over did not burn. The product was then put into a small tube, containing

* Register of Dissections of the Royal Infirmary, Edinburgh, v. 3, p. 164. Case drawn up by Dr. J. Reid.

sub-carbonate of potass ; but no trace of alcohol was detected.

A portion of the brain, equal in bulk to about fl. 3vij. was distilled in a matrass heated in the oil bath, without the addition of water. The product, 3ss. was re-distilled from sub-carbonate of potass. The product of this second distillation did not burn, and it was, therefore, put into a small tube containing sub-carbonate of potass ; but not the slightest trace of alcohol was detected.

The bile was treated in the usual way, and the same result was obtained.

All the analyses were conducted with the greatest care which I could bestow. I have much pleasure in acknowledging the kindness of Dr. Christison in allowing me to perform these experiments in his laboratory.

In the course of my investigation, it occurred to me, that by careful experiment I might possibly be enabled to determine the rapidity with which alcohol, when introduced into the stomach, is transferred to the brain. To this end I proposed to administer a dose of alcohol, and, at the expiration of a few minutes, to destroy life

by prussic acid. But, fortunately, as will appear, it was not found necessary to resort to the last-mentioned poison. Many eminent physiologists have, of late, been engaged in researches to discover the times required for the transmission of various poisons from one part of the system to another; and the facts which they have communicated to the world are interesting and important. I am happy, therefore, to add the following result, as I am not aware that alcohol has hitherto been made the subject of a similar experiment:—

EXPERIMENT VI.

At 3^h. 54^m. P.M. with the assistance of my friend Mr. Wright, I injected ȝij. and ȝiij. of alcohol, sp. gr. 850^o, into the stomach of a full grown spaniel bitch. There was little struggling during the passage of the instrument; but scarcely was the injection completed, when the animal uttered a loud plaintive cry, and, being dropped by Mr. Wright, fell lifeless to the ground. Not a gasp was afterwards taken, nor, after the lapse of one or two minutes, could a single pulsation of the

heart be felt: the function of respiration and the action of the heart, remarkable to say, were suddenly and almost simultaneously arrested. Yellowish feces were evacuated, and the pupils appeared to be dilated to the greatest possible extent. Never did I see every spark of vitality more effectually and more instantaneously extinguished! And what is exceedingly curious in this instance, the same animal had previously recovered from the effects of an injection of $\frac{3}{4}$ iv. of the same alcohol, and continued to the present time, to all appearance, in a perfect state of health.

I proceeded, as soon as possible, to remove the brain, which, in order to save time, was effected by splitting the head longitudinally on a line with the longitudinal sinus. At 10 minutes past 4, precisely, the brain was extracted, instantly cut into slices, and introduced into a matrass. The usual precautions being observed, distillation was immediately performed, and the process concluded. I obtained a supernatant stratum not less than $\frac{1}{3}$ of an inch in depth, which burned with a blue flame, and dissolved camphor.

The blood, also, procured from the different cavities of the heart and great veins of the chest, furnished, on analysis, a stratum of alcohol $\frac{1}{2}$ an inch in depth. On opening the chest, a decidedly alcoholic smell was perceived, as evidenced by Mr. Wright, my brother (who was ignorant of the experiment) and myself. The brain also was thought to emit a somewhat spirituous odour.*

Nothing abnormal was found either in the stomach or intestines. The stomach was nearly void, containing only some bilious matter; and the intestines also were generally void and contracted.

The muscles were sensible to the stimulus of galvanism and the scalpel.

Now it may be observed that not only must alcohol have been conveyed from the stomach to the brain, in the course of one or two minutes after the injection, for at this period the heart's action ceased, but that a considerable quantity also must have passed into the current of the cir-

* Vide case before referred to in "Lancet," v. 1, 1836-37, p. 271. "Effusion to a moderate extent in both pleuræ; this effusion was thought to smell slightly of ether—the pericardium contained some fluid, which was also thought to smell slightly of ether."

culation; for the actual amount of alcohol yielded by the brain in this instance equalled, if not exceeded, what I have in general obtained, when the poison has been allowed much longer time for absorption. Besides, the blood furnished an abundant quantity of alcohol. It is essential to remark that the animal, for a day or two before death, had received but a very scanty supply of nutriment; so that the condition of the stomach and intestinal canal was extremely favourable for rapid absorption, as may be concluded from the beautiful experiments of Magendie. The empty condition of the stomach may, also, serve to explain the extraordinary rapidity with which the alcohol produced its effects in this instance.

As might be anticipated, I have not always succeeded in detecting alcohol in the brain after the injection even of a considerable quantity into the stomach. Nevertheless, as the experiments in which I have failed are interesting in a physiological point of view, I shall proceed to relate them.

EXPERIMENT VII.

At 20 minutes past 12, A.M. with the assistance of my friend, Mr. Wright, I injected $\frac{3}{4}$ ij. of alcohol, sp. gr. 850° , into the stomach of a powerful bull terrier bitch, which had recently pupped. In the morning and during the previous day, her food consisted only of bread and milk. As soon as the injection was completed, the animal howled loudly once or twice, and then fell prostrate; immediately after which, copious evacuation of urine and feces took place; and there was also slight convulsive extension of the back and limbs. Death already appeared to have supervened, but it was only apparent; for although the respiration was arrested, the heart steadily continued to beat, and after the lapse of 3 minutes a sudden deep inspiration was taken. The respiratory function was gradually restored, but continued oppressed, and, for some time, chiefly abdominal. It was not until 1 o'clock that the animal sufficiently revived to be able to give any indication of the return of voluntary power: at 1 o'clock, for the

first time, she endeavoured to raise her head. I then carried her into an adjoining apartment, and left her for 15 minutes. On my return, I found that she had so much recovered as to have turned herself over, and to be able to stagger a few steps. Her hinder extremities appeared paralysed. The pulse and respiration had become more natural. At 1^h. 35^m., I again left her lying upon her left side; a position which she never afterwards changed. I occasionally returned. She gradually sunk, apparently in pain, as she continued for some hours to moan at each inspiration. At $\frac{1}{2}$ past 8, I found life to be quite extinct; and as stiffening had not then taken place, although it *subsequently* occurred, she could not have expired long before my arrival. With regard to the state of pulse, I may observe, that at first it was characterised by intermission, irregularity, and weakness; and afterwards by rapidity and greater weakness: at 12^h. 36^m. it was 92; 12^h. 54^m. between 80 and 90; 2^h. 26^m. 115; 5^h. 115. At 12^h. 41^m. the respirations were 30 per minute. Of the other symptoms which I remarked, I may mention the following:—at first, the direction of the eyes down-

wards and inwards—the contraction of the pupils—the oscillating movement of the eye-balls from before backwards—dimness of the conjunctiva—slight epistaxis—the tongue pendulous from the mouth, and apparently paralysed—slight convulsive movement of the muscles at the angles of the mouth.

Post-mortem, on the following morning. My respected friend, Dr. Howitt, Physician to the Nottingham Infirmary, kindly assisted me.

Head. On cutting through the right temporal muscle, a quantity of *dark fluid* blood oozed out. The vessels of the brain appeared to be somewhat congested : the bloody points were thought to be larger than usual. I, unfortunately, lacerated the brain in removing it, and I did not examine the ventricles *in situ*; so that I cannot make any positive statement as to the presence of effusion. However, I saw no reason to believe that effusion did take place.

Thorax. The lungs were redder than natural, and the bronchi and air-passages were filled with frothy serum-like liquid. The heart—dark colour-

ed and perfectly fluid blood was contained in all its cavities: there was no trace of a clot.

Abdomen. Liver, spleen, and kidneys, natural; not so, however, the pancreas, which presented a beautiful and variegated appearance; that part of it contiguous to the intestine on the right side was much congested; and in the same part, also, there was bloody extravasation under the serous membrane, and between the lobules; which circumstance produced the variegated appearance. Stomach—it contained a considerable quantity of bread in a pulpy condition. The mucous membrane generally presented a florid injection, which was intense near the pylorus, where strings of tenacious and viscid mucus or lymphy matter, were observed crossing from one ruga to another. The same appearance was also presented in other parts of the viscus, especially near the cardiac extremity; though not to so great an extent. Two or three small, irregular, deep brownish black patches of extravasated blood existed near the pylorus; and in the vicinity of the cardia also, in a space about 2 inches in length, and one in breadth, were numerous and de-

fined similarly coloured patches, interspersed with similarly coloured spots and striæ. These appearances remained, after rather roughly scraping off the superjacent mucus, or lymphy matter ; indeed, they then became better defined. The mucous membrane of the duodenum was much injected, and throughout the intestinal canal, the mucous surface presented at intervals extensive patches of vascularity. The bladder was contracted, and completely evacuated. The *blood was everywhere fluid* ; and this circumstance forcibly arresting our attention, we determined the accuracy of it with particular care.

Chemical examination. The brain, the blood, the bile, and the contents of the stomach were subjected to very careful analysis ; but alcohol was not detected in any of these substances, not even in the contents of the stomach.

Having now related one experiment, in which, after the injection of a considerable quantity of alcohol into the stomach, I failed to detect any trace of alcohol in the brain, I shall next endeavour briefly to account for this failure. At first, extraordinary prostration was occasioned, and so

instantaneously, as to lead us to acquiesce in the theory of Sir Benjamin Brodie,* and believe, that the nervous system received a powerful and instantaneous impression through the medium of the nerves of the stomach. For, notwithstanding the rapidity with which we have seen that alcohol may be conveyed from the stomach to the brain, we cannot conceive, that, in the instance before us, absorption to a sufficient extent could possibly have been instantaneously effected. This death-like prostration, however, of the vital powers was not of long duration : the animal, as it were, gradually resuscitated, and, in a short time, so much recovered, as to be able to stagger about the apartment. But another and fatal train of symptoms succeeded : the animal lingered for many hours, suffering apparently from the effects of gastro-intestinal inflammation, and, at length, in the evening expired. That death was in great measure, if not entirely, caused by this inflammation, it will not, I think, after a careful review of the symptoms and post-mortem appearances recorded, be denied. Now the effect of this

* Vide Philos. Transac. 1811, p. 178 et seq.

violent inflammation, which the alcohol, by virtue of its irritant action, excited, would be to rouse the animal from her comatose condition, and to accelerate the action of the heart;* in consequence of which acceleration, any alcohol that might have been conveyed to the brain, would be more quickly removed, and exhaled at the lungs; and be it remembered, that the existence of the animal was protracted for more than seven hours after re-action commenced.

Acute inflammation of the stomach and intestines, after poisoning by alcoholic liquors, has rarely been found in the human subject. I have, however, met with the following case:—

“ David Torrington, on the afternoon of the 27th of June, 1818, drank a quantity of pure rum, supposed about 2 pints; he shortly became in-

* The manner in which the heart is affected by irritation of the bowels, or other organs, is explained on the mysterious principle of sympathy. Vide Cyclop. of Pract. Med. Art. “ Irritation,” by C. B. Williams, p. 876. “ In all febrile diseases and considerable inflammations, the heart is sympathetically irritated, whence the quick pulse and hurried circulation; but the main and most important seats of irritation, either primary or sympathetic, are the mucous membrane of the stomach and bowels, and the brain.” (*Broussais' doctrine.*)

sensible, and was found in that state under a hedge, near the West India Docks. A surgeon, passing by, bled him, and ordered him to be sent to the London Hospital. When admitted, he was in a state of total insensibility, he had stertorous breathing; frothing at the mouth; dilated pupils, which, however, contracted on holding a candle to the eyes, and a very full and hard pulse. A drachm and a half of the sulphat of zinc was given, which operated well. At 11 at night, the same symptoms continuing, he was bled again largely, his head was shaved, and a cold lotion applied to it. On the following morning, he was sensible when roused, but was heavy and drowsy. In the course of the day he was well purged, bled again, and kept on low diet, and appeared to be recovering. On the 30th, he complained of pain in the region of the stomach, and on the 1st of July, he became furiously delirious; on the 2d, he had roving slow delirium, and copious perspiration, his strength failed him, he appeared sinking, and about midnight he died. On examination, the vessels of the posterior part of the brain only were found rather turgid; the quantity of fluid in

the ventricles was natural, and there was no rupture of blood vessels. The internal coat of the stomach was inflamed in patches, as also the internal and external coat of the intestines.”*

The next experiment is one, which illustrates, in a remarkable degree, the intensely irritant action of alcohol, and also the rapidity with which this action may be developed:

EXPERIMENT VIII.

At 8^{h.} 22^{m.} P.M. I injected $\frac{3}{4}$ iv. of alcohol, sp. gr. 850°, mixed with $\frac{3}{4}$ j. of the oil of juniper, into the stomach of a large, powerful, and full-grown ‘brindled’ dog. No immediate and apparent effect was occasioned: the animal walked about the room just as he had done for some time before the injection.

8^{h.} 27^{m.} He began to stagger, and vomited a quantity of frothy liquid, exhaling a strong odour of juniper. The vomiting recurred several times.

9^{h.} 10^{m.} I injected $\frac{3}{4}$ iv. more of the same alcohol. He struggled much and endeavoured to bite.

* Cooke on Nervous Diseases, v. 1, p. 219.

9^h. 19^m. After constant walking about in a restless manner, he lay down upon his belly.

I then left him, and at 10^h. 8^m. I returned, when I found him still in the same position, although he had changed his situation in the apartment. He had again vomited frothy matter, which was strongly tinged with blood. He reeled and staggered when raised.

11^h. I administered a dose of prussic acid (of Scheele's strength), which quickly extinguished life. There was slight opisthotonus. A short time previous to the second injection, I laid some strychnia upon his tongue; but he vomited soon afterwards, and the poison did not produce any effect.

My object in combining oil of juniper with the alcohol of the first injection, was to ascertain whether I could detect the odour of this oil, which is so peculiar and so powerful, in the brain; and it was, therefore, that I attempted to destroy the animal by strychnia. Failure, however, in this attempt, and the violent sickness, which was, probably, much increased by the oil, prevented all chance of success. It is worthy of remark, that,

notwithstanding the intense gastric inflammation, which, as we shall presently see, was produced, the animal never moaned or howled, except when the prussic acid excited convulsion.

Post-mortem in the afternoon of the following day. Stiffening took place, but the blood very imperfectly coagulated.

Head. No morbid appearance was found in the brain. The hemispheres were sliced off *in situ*, but no fluid was discovered in the ventricles ; nor could the slightest odour of alcohol, or oil of juniper be detected either before, or after the process of slicing.

Thorax. The lungs were slightly congested. Dark blood was contained in *all* the cavities of the heart ; but in greater proportion in the right than in the left side.

Abdomen. Solid viscera healthy. The stomach bore the marks of the most intense inflammation. Its *internal* surface was covered with very viscid, tenacious, and bloody mucus (?). In the vicinity of the pylorus this surface had a bright cherry-red colour, except in the intervals of the rugæ, where the colour was yellowish-red. The remain-

ing part of the internal surface was covered with large irregular patches of extravasated blood. The rugæ of this part were swelled and flaccid, especially along the great curvature. After carefully scraping off the superjacent mucus (?), the membrane presented the same appearance as in a former experiment,—it could easily be detached in crumbling pieces, and had a dirty chocolate, or liver colour. In the intervals of the rugæ existed florid-red injection.* On the *external* surface, also, there were signs of extravasation from the vessels enclosed by the peritoneal laminæ, which descend from the inferior or great curvature. There was no appearance of inflammation in the intestinal canal. The smaller intestines were contracted, whilst the larger contained feces. The bladder contained but little urine.

Chemical examination. No trace of alcohol was found in the brain. I did not subject the blood to analysis.

* The whole internal surface exhaled the odour of juniper, and three days afterwards this juniperous smell was retained; although the stomach had been freely exposed to the air during that time.

ANALYSIS OF THE BRAIN,

AFTER THE

INJECTION OF ALCOHOL INTO THE JUGULAR
VEIN.

EXPERIMENT IX.

At 5^{h.} 2^{m.} P.M. I injected 3vj. of alcohol, sp. gr. 860°, into the jugular vein of a young bull terrier dog: every precaution was taken to avoid the introduction of air. No apparent change took place during the process of injection.

5^{h.} 5^{m.} The urine was evacuated, and the respiration was laborious.

5^{h.} 7^{m.} The pupils, which a minute before were contracted, were dilated, and the heart's action feeble.

5^{h.} 10^{m.} Pupils much dilated, and eye-balls insensible when touched,—heart's action entirely ceased.

Post-mortem, immediately after death.

Head. No abnormal appearance was found in the brain. In common with two gentlemen who kindly assisted me, I thought that the brain had a spirituous smell.

Thorax. Thoracic viscera healthy. Both ventricles of the heart contained blood. The blood collected in the chest after section of the *cava* had a spirituous smell.

Abdomen. Abdominal viscera healthy. The bladder was completely evacuated.

The blood coagulated, and the muscles were excited to contraction both by galvanism and mechanical irritation.

Chemical examination. I obtained from the brain a stratum of alcohol about one line in depth; and a small quantity of alcohol was also separated from the blood, taken from the left ventricle of the heart.

Now it is stated by Orfila, that alcohol injected into the jugular vein causes sudden death, principally by coagulating the blood; * and this ex-

* *Traité des Poisons.* Q^{ième} ed. tome 2, p. 414. Vide "Gazette des Hôpitaux." Paris, Janvier 25, 1838. "M. Royer Collard a voulu voir quels seraient les effets des injections d'alcool

planation has been generally received as satisfactory. I have, however, endeavoured to put this explanation to the test of experiment, and the results which I have obtained by very careful examination immediately after death, have induced me to believe that it is incorrect. To question the accuracy of so high an authority as Orfila, might possibly be considered presumptuous; but I shall minutely relate the experiments which have led me to entertain a difference of opinion, and I doubt not, that strong grounds will appear in justification. I am indebted to my esteemed friend, Dr. J. Reid, for his kind assistance in this part of my investigation; and it is no inconsiderable source of satisfaction to me, that one already so distinguished for his researches in some of the most intricate parts of physiology, was an eye witness to my results.

dans les veines d' un animal, et il a constaté avec M. M. Dumas et Poiseuille qui l' ont aidé dans ses recherches, une coagulation assez rapide quand les quantités d' alcool injectées étaient considérables."

EXPERIMENT X.*

May 4th, 1838, Edinburgh. At 3^{h.} 18^{m.} P.M. precisely, I injected rapidly 3ss. of alcohol, sp. gr. 840°, into the jugular vein of a small terrier. The pupils immediately became intensely contracted, and the respiration appeared at first to be completely arrested; but the heart steadily continued to beat. He was gradually recovering, when, at 27^{m.} past 3, I repeated the injection of the same quantity of alcohol. Life seemed to be instantly extinguished; there was forcible evacuation of feces,—the jaws were firmly clenched,—the eye-balls were perfectly insensible, fixed, and directed downwards and inwards,—the pupils much dilated,—and there was also slight moaning, but no convulsive movement. At 28^{m.} no pulsation could be felt. The chest was immediately opened. The muscles contracted under the scalpel; but the heart did not contract when irritated, until it was emptied. Although the respiration had completely ceased, yet several

* My friends Drs. Reid and Spence, and Mr. Robertson present.

gasps were taken during the process of opening the chest. A strong and unequivocal smell of alcohol was perceived in the cavity of the chest. The right side of the heart was fully distended with dark and *perfectly fluid* blood, which became red, and coagulated, on exposure to the atmosphere. From 3 to 5 minutes elapsed between the injection into the vein and the examination of the heart. The blood was very carefully examined, yet not the slightest trace of coagulation was detected in the cavity of the heart. It issued from a small orifice, made by the point of a scalpel in a perfectly fluid stream.

The head was opened on the following day in the presence of the same gentlemen. A decided smell of alcohol was instantly perceived ; and the brain yielded on analysis a very sensible quantity of alcohol. The ventricles contained about 3ss. of effusion, which was carefully distilled from sub-carbonate of potass. The first drops, which came over, were tested, but they did not burn. The product was then put into a small tube, containing sub-carbonate of potass. No indication, however, of alcohol, was obtained. This is well worthy

of attention, and is a remarkable fact. The method of analysis was extremely delicate; so that if there had been only a minute quantity of alcohol present, it would certainly have been detected.

EXPERIMENT XI.*

May 5th, 1838, Edinburgh. At 2^{h.} 59^{m.} precisely, I slowly injected 3ss. of alcohol, sp. gr. 840°, into the jugular vein of a terrier. The heart's action became extremely rapid. Convulsive twitches of the tongue and muscles of the face, and continual twinkling of the eye-lids succeeded. Feces were forcibly evacuated; pulse 138. At 3^{h.} 8^{m.} I repeated the injection. In 30 seconds the heart ceased to beat; subsequently a few gasps were taken. The chest was immediately opened, and at 3^{h.} 14^{m.} 30^{s.} precisely, the superior *cava* was punctured with the point of a scalpel,—a perfectly *fluid* stream of blood issued from the puncture, on slightly compressing the right auricle and ventricle. Not the slightest appearance of coagulum was found in this ven-

* The same gentlemen present.

tricle and auricle, which were distended with blood. One or two feeble gasps occurred after the chest was opened, and the heart was seen to be affected by them. The heart contracted when emptied.

The brain was removed on May 7th. No alcoholic odour was detected, nor was effusion in appreciable quantity found in the ventricles. A sensible quantity of alcohol was obtained on analysis. Distillation was effected without the addition of water in the chloride of calcium bath.

That in these experiments death was not occasioned by the coagulation of blood, no doubt, I think, can be entertained. I endeavoured as far as I was able to avoid every source of fallacy. The brain and nervous system generally appear to have been almost instantaneously affected ; and it is, therefore, probable that death was caused by the direct action of the alcoholic poison upon the nervous matter, and the consequent annihilation of the animal functions. It occurred to me that possibly the alcohol might produce some effect, by lowering the temperature of the blood contained in the right side of the heart. In order

to obviate this source of fallacy, the following experiment was performed.

EXPERIMENT XII.

I injected 3ss. of cold water into the right jugular vein of a middle sized mongrel bitch, but no appreciable effect was occasioned. Whilst I injected, my friend Dr. Reid carefully observed the action of the heart, but not the least alteration was detected. The injection was repeated with rapidity, and with the same result. I then injected 3ss. of alcohol, sp. gr. 840°,—the breathing was immediately affected, but the heart continued to beat. 3ss. was again injected,—immediately afterwards the heart's action ceased, the respiration was completely arrested, the pupils were extremely dilated, and in short, the animal was in a state of profound coma. In about a minute or two he began to gasp feebly at intervals of several seconds, when a third 3ss. of alcohol was injected,—life was instantly extinguished. The chest was immediately opened. The lungs collapsed. The venæ cavæ and right side of the heart were distended with dark, and,

excepting about 3ss. which at first issued from a small puncture in the superior cava, with perfectly *fluid*, blood. The 3ss. which at first issued was coagulated, and consisted of reddish brown flocculi (albumen ?); it was exactly similar to that which I have obtained, on allowing the blood from the arm of a human subject to flow into a vessel containing alcohol. This trace of coagulation does not invalidate my former conclusion ; for it must be borne in mind, that the third injection was not made until the heart had ceased to beat for some time.

The muscles contracted under the stimulus of the scalpel. The heart contracted, though not vigorously, when even all its cavities were cut open. There was a little coagulated blood in the vein above the ligature ; which cannot appear surprising, when we consider the injury which the vessel received, and the long period it remained freely exposed to the air. The head was opened on the third day after the experiment, when we thought we could detect the odour of alcohol, especially during the process of slicing the brain. The pia-mater was, if any thing, less injected

than natural. A sensible quantity of alcohol was separated from the brain in the usual manner.

My respected friend, Dr. Cogswell, has communicated to me a very remarkable result: he "injected alcohol into a dog's (jugular) vein, expecting it either to kill him immediately or not at all, whereas the animal died in two or three days." From the following experiment, however, it will be seen, that half an ounce of alcohol may be slowly injected into the jugular of a dog, without producing any very marked and formidable effect.

EXPERIMENT XIII.

At 8^h. 15^m. A.M. I *slowly* and steadily injected 3ss. of alcohol sp. gr. 850°, into the left jugular vein of a young mongrel bitch. No immediate and apparent effect was produced. In 10 minutes the eye-lids were nearly closed, the pupils much contracted, and the eye-balls directed forcibly downwards and inwards, retaining, however, complete sensibility to the touch. The breath soon after the injection acquired a spirituous odour, which was again remarked at half past 8. At 8^h. 32^m. there was very forcible evacuation of feces,

and the limbs appeared quite powerless. At 8^{h.} 40^{m.} the hinder extremities were drawn up; and when I extended them, they contracted as soon as my hand was removed—the whole body also was affected with tremor. I then uttered signs of caress, and the animal instantly responded by wagging her tail and moving her head: the pupils were nearly natural. At 8^{h.} 45^{m.} she could stagger about, the hinder extremities appearing paralysed. At 9^{h.} 30^{m.} she had much recovered, could walk without staggering, and ate bread and milk with avidity. She perfectly recovered from the effects of the injection, and I kept her for a week afterwards.*

* I have met with the following experiments upon the injection of alcohol into the veins of dogs, performed so long ago as in the year 1679, by M. Courten, of Montpelier: “*Feb. 27*, we injected two drams of highly rectified spirits of wine, into the crural vein of a dog; the dog died in a very little time, very quietly, and with pleasure as it were, licking his jaws with his tongue, and breathing quick, but easily, without barking, crying, or any convulsive motion. The blood was concreted into a great many livid hard clots in the *cava*, and right ventricle of the heart. These appeared still more conspicuous, and harder in some blood, that flowed back from the vein into the syringe.”—“*March 2*, we injected three drams of rectified spirits of wine into the crural vein of a small dog, which made him apoplectic, and as if he were half dead. In a little time he recovered from his apoplexy, but grew

giddy ; and when he endeavoured to go, reeled, and fell down ; though his strength increased by degrees, yet his drunkenness still continued ; his eyes were red and fiery, and his sight so dull, that he did not seem to take notice of any thing, and when beat, would scarce move ; however, in four hours' time he grew better, and would eat bread when we gave it him. The next day he was brisker, and seemed to be past all danger."—" We injected into the crural vein of a dog, five ounces of a strong white wine, which made him very drunk, and little different from what a less quantity of spirits of wine would have done ; but in a few hours his drunkenness abated, and he recovered."

Medical Essays and Observations abridged from the Philosophical Transactions. By S. Mihles, M.D. v. 2, p. 31-32, 1745.

ANALYSIS OF THE BRAIN,

AFTER THE

INJECTION OF ALCOHOL INTO THE CAROTID
ARTERY.

EXPERIMENT XIV.

At 4^{h.} 24^{m.} P.M. precisely, I injected* 3ss. of alcohol, sp. gr. 850°, into the left carotid of a full grown spaniel dog. Instantly, the animal struggled, and emitted a plaintive cry; but entire loss of sensibility and voluntary power immediately succeeded, and the animal ever afterwards remained in a state of prostration on the right side. In one minute the breath acquired a decidedly alcoholic smell,—the pupils were exceedingly dilated,—the mouth was open, and the tongue pendulous from it,—the abdominal muscles were forcibly con-

* The vessel being first tied, a very small opening was made *above the ligature*, and the extremity of a fine silver tube attached to a syringe introduced. On withdrawing this tube after the injection, the vessel was again tied *above the opening*.

tracted, and the respiration very laborious. In 5 minutes more, the heart's action was irregular and intermitting, the inspirations were interrupted, and the breath had no longer a spirituous smell. 4^{h.} 39^{m.} the pulse was between 40 and 50, full and irregular, but not intermitting.

Slight epistaxis now occurred,—there was also convulsive twitching of some of the muscles of the neck, and of the superior portions of the fore extremities, and convulsive tremor speedily extended to the whole frame. The state of the respiration was now characteristic of the most profound coma, and it seemed scarcely possible for the animal to survive the duration of a few minutes,—the cornea had become dim, and when the body was pricked in different parts with the scalpel, not the slightest indication of sensibility was evinced.

Intense reaction, however, subsequently took place, as will presently appear. At 5^{h.} 40^{m.} I left the animal in the same profoundly comatose state, attended with occasional convulsive twitching of the extremities. At 6^{h.} 41^{m.} I returned,—reaction had commenced, the pulse being more than 140,

the pupils nearly natural, and the mouth closed,—the conjunctiva injected and much brighter than previously,—the respirations oppressed, occasionally short and interrupted, and accompanied with a loud tracheal râle 9^h. 20^m. life was quite extinct ; but stiffening had not then commenced. About half an hour previous to this time, he was found gasping feebly at intervals.

Post-mortem on the following morning.

Head. The contents of the cranium, even *before* the dura-mater was detached, emitted a strong and unequivocal smell of alcohol. The vessels of the brain were congested, and a minute quantity of serum-like liquid, of which I was unable to procure sufficient for analysis, was found in the ventricles.

Thorax. The lungs had a florid-red colour. The bronchi and air-passages were filled with thin liquid, of a slight red tinge ; the lining membrane appeared natural. The blood in all the cavities of the heart was dark, and coagulated about as firmly as usual, and became red on exposure to the air. The great veins were fully distended with coagulated dark blood.

No morbid appearance was found in the abdominal viscera.

Chemical examination. The brain was treated in the usual manner, and furnished a stratum of alcohol half an inch in depth. The blood from the chest was also subjected to analysis, but yielded no trace of alcohol.

Now we learn from this experiment one fact, which is very remarkable and difficult of explanation ;—only four drams of alcohol were introduced into the system through the carotid artery, and yet, notwithstanding that the animal survived the injection four hours, and that intense reaction supervened, a considerable quantity of alcohol, comparatively speaking, was extracted from the brain. The poison, it is true, was propelled directly into the vessels of the brain ; but, at first, it was, most probably, carried through those vessels to the lungs, as the breath, soon after the injection, acquired a strong alcoholic smell. It is, however, evident from the amount of alcohol obtained on analysis, that a considerable portion of the four drams must have remained in the brain ; and it is also evident, from the powerful

odour of alcohol immediately perceived on the removal of the skull-cap, that some of this portion must have been diffused through the cerebral substance, or, at least, have exuded from the cerebral vessels. Hence, we are led to infer, either that an impediment was caused to the transmission of the alcohol, and, consequently, to the progress of the blood, through the cerebral vessels; or that the alcohol exuded from these vessels, and proceeded to those parts of the cerebral substance, from which the circulation was not adequate, at least in a short time, to remove it. The latter supposition is probably the nearest approximation to truth; for we have already seen with what pertinacity alcohol may adhere to, or, as it were, combine with, organic tissues. Hence, also, it appears probable, that some of the alcohol was retained by the coats of the cerebral vessels, although the circulation through these vessels may have continued as usual.

EXPERIMENT XV.

At 2^{h.} 27^{m.} P.M. I *slowly* injected 3ss. of alcohol, sp. gr. 840⁰, into the right carotid of a large

mongrel dog. About two inches of the fine silver-tube attached to the syringe, were passed up the vessel. Before the injection was completed, the animal became violently convulsed, and moaned loudly,—the urine was forcibly evacuated,—sensibility was not quite destroyed. The convulsive action continued with slight intermissions for some minutes. The respiration was heaving, and the inspirations succeeded at intervals of a minute. At 10 o'clock in the evening, I found the animal in the same profoundly comatose state,—the heart's action slow and intermittent,—the pulse of the thigh distinct,—the inspirations deep and convulsive, and performed at intervals of several seconds,—the surface cold, and the whole body and limbs, especially the hinder, affected with convulsive tremor.

Two days afterwards (Sunday being allowed to intervene), I found him dead in precisely the same situation. I may state, that two minutes after the injection, the breath was observed to be strongly alcoholic by all present; and the same was again remarked at 2^h. 33^m. The pulse was, at first, extremely rapid.

The head was carefully examined. The piamater was minutely injected. The ventricles contained only a few drops of limpid fluid. Not the slightest odour of alcohol was detected, either before or during the process of slicing. The brain was subjected to careful analysis, but no trace of alcohol was obtained. This result is very different from that of the preceding experiment. The time, however, allowed to elapse before the examination, the greater protraction of life, and the *much larger* size of the animal in the latter experiment, will sufficiently explain the difference of result. The physiological effects observed in the two experiments were, in all respects, similar. I may remark, that in injecting into the carotid great care is required. I injected 3ss. of alcohol into the right carotid of a large dog,—violent convulsive action was immediately excited, but with the exception of slight intoxication, the animal suffered no injury. From this it is evident, that only a minute quantity of alcohol reached the brain.

In order to determine the effect which the mere force of the injection would produce upon the brain, I performed the following experiment.

EXPERIMENT XVI.

At 3^h. 34^m. I injected 3ss. of tepid water, with the same force, as nearly as I could estimate, as in the preceding experiment, into the right carotid of a mongrel bitch. General convulsive action was excited a little before the completion of the injection, and continued for several seconds. At 3^h. 35^m. however, she raised her head, and appeared to have completely recovered. At 3^h. 37^m. I injected a syringeful (fl. 3ss.) of common air into the carotid of the same dog,—violent convulsive action was instantly occasioned,—the tail, back, and limbs were forcibly extended,—the abdominal muscles were powerfully contracted,—and there was also loud moaning,—the heart's action continued slow and strong,—respiration soon ceased, and, in all probability, would not have been restored. After the lapse of two or three minutes, during which time not the slightest attempt at inspiration was observed, a gasp was immediately excited by pinching the par-vagum,—the respirations then continued to be performed with considerable intervals between the inspirations, for

at least a quarter of an hour. The animal functions appeared to be completely suspended, whilst the organic functions proceeded, though in an imperfect manner,—in short, the animal lay in a state of most profound coma. The respiration continued even after the section of the paravagum, and both recurrent nerves. Numerous globules of air were sufficiently apparent in the minute vessels of the pia-mater.

In order more fully to illustrate the physiological action of alcohol, I shall introduce some experiments, in which I failed, even after the injection of a considerable quantity of alcohol into the stomach, to produce the desired effect—death.

EXPERIMENT XVII.

At 7^{m.} before 3, P.M. precisely, I injected ȝiv. of alcohol, sp. gr. 850°, into the stomach of a large old spaniel dog. At 3^{m.} before 3, symptoms of uneasiness were evinced, and at 1^{m.} before 3 he fell, after much staggering, upon his belly: the hinder extremities appeared paralyzed. The

pupils were observed to dilate and contract alternately, at intervals of a few seconds.

3^h. 10^m. Pulse 65 in 30 seconds, full. Respiration audible, hurried, and irregular: each inspiration was, for some time, interrupted, and broken into 3 short gasps.

3^h. 15^m. During the last 2 or 3 minutes, the extremities have been affected with slight alternate movements of flexion and extension. Abdominal muscles and diaphragm were thrown into violent action, and vomiting of a frothy slimy liquid, mixed with pieces of bread, and exhaling a strong spirituous smell, succeeded. After this, the pupils were found to be intensely contracted, and the pulse somewhat diminished in strength.

The vomiting recurred. On the following morning he appeared to have quite recovered, as he ate with avidity, and caught the food as I threw it towards him. I may observe, that in the course of the experiment, I pressed my hand several times upon the region of the stomach, but did not remark any alteration of symptoms indicative of an aggravation of suffering.

Four days afterwards, I destroyed this animal

with strychnia. The stomach and intestines appeared perfectly healthy. On the surface of the *spleen* there were two small swellings (about the size of small marbles), which, when cut into, seemed to be progressing towards suppuration. A cyst of considerable size was found in the right kidney.

EXPERIMENT XVIII.

At 6^h. 35^m. A. M. precisely, I injected 3ij. 3v. of alcohol, sp. gr. 850^o, into the stomach of a full grown spaniel bitch. Symptoms of intoxication were soon produced. The pupils alternated between contraction and dilatation.

6^h. 48^m. Has not been able to stand for some time; on endeavouring to raise her head, she immediately lets it fall as a dead weight.

6^h. 55^m. Jaws now in action, as in mastication. Occasional whining. Slight spasmodic extension of extremities.

6^h. 56^m. Evacuation of urine. Breath strongly alcoholic. Constant wagging of tail, and movement of fore legs as in running.

6^h. 59^m. Vomiting of a kind of frothy mucus. The animal, still lying upon the floor, continued extremely restless:—at one time writhing, and contorting her body in all directions, and occasionally moaning, whining, and howling loudly, as if suffering severe pain; and at another time, appearing to be in a state of delirious excitement, the tail and all the extremities being affected with rapid movement, as if she were endeavouring to swim, or in swift pursuit of some object of prey; and once, indeed, she violently shook her head, as if she had grasped her imaginary victim.

3^h. 38^m. P.M. Much recovered. I found her sitting up, and attempting to walk. Her hinder extremities seemed paralyzed, and, indeed, were even thought to continue so for several days afterwards. In the evening she ate food, and appeared, comparatively, well.*

The symptoms which Orfila describes, as resulting both from the injection of alcohol into the stomach, and into the cellular tissue of the thigh of a dog, are very similar to those which I have de-

* Fearing lest the detail should be thought tedious, I have suppressed several experiments, which appeared originally in my Thesis.

tailed in the preceding pages ; and I, therefore, subjoin the description of Orfila in his own words :—

“ A 8 $\frac{1}{2}$ du matin, nous avons introduit dans l'estomac d'un petit chien robuste 6 gros d'alcool à 40°, l'œsophage a été lié. Immédiatement après, l'animal a paru agité ; il a parcouru le laboratoire en différens sens, et n'a pas cessé de marcher librement pendant dix minutes ; il avait un air égaré. A huit heures trois quarts, il a commencé à éprouver des vertiges. A neuf heures dix minutes, il s'est couché sur le côté et ne pouvait plus se tenir debout. Jusqu'à ce moment, il avait marché en différens sens, s'était tombé plusieurs fois, mais s'était relevé aussitôt ; ses extrémités n'avaient point été paralysées. A neuf heures vingt-cinq minutes, il a poussé des cris plaintifs et a fait des efforts infructueux pour lever la tête ; les membres étaient flasques, la pupille resserrée ; il voyait et entendait bien ; ses muscles n'étaient agités d'aucun mouvement convulsif. Dix minutes après, les plaintes étaient aiguës. A neuf heures quarante minutes, il a cherché à se mettre sur les pattes ; mais il est tombé aussitôt en frap-

pant le sol avec sa tête ; quelques instans après, il a fait de nouveaux efforts, s'est relevé, a marché pendant quelques secondes, et est retombé en poussant des cris aigus. A onze heures, il était couché sur le côté et continuait à souffrir ; point de mouvement convulsif. On l'a ouvert à 2 heures. Le sang contenu dans le cœur était noir et coagulé ; les poumons n'offraient aucune altération ; la membrane muqueuse de l'estomac était d'une couleur rouge-cerise dans toute son étendue, et offrait un très-grand nombre de bandes longitudinales d'un rouge noirâtre, formées par du sang extravasé entre les deux tuniques.” *

“ Lorsqu'on injecte dans le tissu cellulaire de la cuisse d'un chien de moyenne taille 8 à 10 gros d'alcool à 40°, on remarque que l'animal est agité ; pendant trente ou quarante minutes, il marche en tous sens avec un air égaré, et n'éprouve point de vertiges ; alors les extrémités postérieures deviennent faibles ; sa démarche commence à être chancelante ; il vomit, à deux ou trois reprises différentes, des matières bilieuses jaunâtres. Quinze ou vingt minutes après, les vertiges sont

* *Traité des Poisons.* Qième ed. T. 2, p. 412.

plus intenses ; l'animal marche comme un furieux, tombe, se relève et continue à parcourir le laboratoire. Bientôt après il éprouve beaucoup de difficulté à se mettre sur les pattes ; il les agite comme s'il nageait. Ces efforts ne tardent pas à être vains : alors il se couche sur le côté, dans un état de grande insensibilité ; les membres sont flasques et n'offrent aucun mouvement convulsif ; l'animal ne se plaint pas, à moins qu'on ne le secoue ; les inspirations sont profondes ; la pupille est comme dans l'état naturel. Ces symptômes persistent pendant deux ou trois heures, et l'animal succombe.” *

* *Traité des Poisons.* Qième ed. T. 2d. 413.

CONCLUDING OBSERVATIONS.

It will not, perhaps, be deemed superfluous to subjoin a brief recapitulation of the most important conclusions, which I conceive I am authorised to draw from the preceding experiments.

First. In reference to the principal object of the investigation, we may conclude that, although no *direct* evidence has been advanced in support of the statement of Dr. Ogston and others concerning the presence of alcohol in the *ventricles* of the brain, after poisoning by alcoholic liquors, yet, the circumstance of alcohol being separated from the brains of dogs, and the human brain, may be adduced as favourable to these statements. It must not, however, be forgotten that I obtained two results, which appear to be at a variance with this conclusion ; for in the two instances in which I found an appreciable quantity of liquid effused into the ventricles, I was unable to detect any

trace of alcohol in this liquid, although a sensible quantity was separated from the substance of the brains. I have already remarked, that I do not consider these results of much weight, as the quantity of effusion in both cases, was, comparatively speaking, so inconsiderable, that the analyses can scarcely be considered satisfactory. Besides, it is necessary to observe that effusion, after fatal intoxication, has frequently been discovered in the ventricles of the human brain ; * although there are only one or two cases recorded, in which this effusion is reported to have furnished any indication of the presence of alcohol. Hence also, the *two* results cannot justly be urged as an objection to the preceding conclusion.

A remark may here be appropriately introduced, respecting the situation in which the alcohol may exist in the brain. That, to a certain extent, it is diffused through the substance of the brain, and that it is not all contained in the cerebral vessels, will, I think, appear from the following circumstance :—namely, that, although I have subjected to analysis a much greater

* Edinb. Med. and Surg. Journ. v. 40, p. 290.

quantity of blood than can possibly be present within the cranium, yet I have, in general, been enabled to procure a much larger proportion of alcohol from the brain, than from all this quantity of blood. Indeed, it would almost seem that a kind of affinity existed between alcohol and the cerebral matter.

Second. The rapidity with which alcohol may, under *favourable circumstances*, be absorbed from the stomach and conveyed to the brain, is remarkable.

Third. That alcohol may be detected in the blood, the urine, the bile, and the liver. It may be separated with great facility from the bile and liver; and this circumstance may probably serve to explain the frequency of hepatic disease in habitual drunkards. I must repeat that I have only once succeeded in separating alcohol from the urine of dogs, although I have several times subjected this secretion to analysis. In the instance in which I succeeded, it will be observed that the bladder was fully distended with limpid urine (*vide Exp. ii.*); and, therefore, that I had the advantage of the most favourable circumstances.

Müller enumerates alcohol amongst the “ matters which, when taken into the stomach, cannot afterwards be detected in the urine.”* I am, however, happy to introduce an analysis of the human urine, in which I have satisfactorily detected the presence of alcohol.

As this result is at variance with the statement of very accurate observers of the present day, Berzelius and Müller, it is incumbent upon me to relate every circumstance minutely. I obtained (in Edinburgh) the urine of a man (a grave digger, who is guilty of habitual intoxication), who was in a state of intoxication; he had taken in all, as nearly as I could learn, about a bottle of whiskey. The urine was clear and of a pale straw colour. I subjected 3v. to distillation over an Argand lamp, and drew over 3ij. of perfectly colourless and transparent liquid, having a peculiar odour very like that of sweet wort. The product was poured into a small matrass, containing an adequate quantity of sub-carbonate of potass, and again distilled. The first drops which came over were examined, and found not to be combustible. I

* Elements of Physiology (translation by Baly), p. 589.

then continued the distillation and drew over 3j. which was put into a test tube, containing sub-carbonate of potass: instantly, on agitation, a perfectly clear and colourless supernatant stratum appeared, which dissolved camphor and burned with a blue flame. This examination was repeated in the presence of Dr. Traill.

Magendie, I believe, was the first physiologist who detected alcohol in the blood;* many attempts, however, having been previously made, but without success. Dr. Trotter, in his work on Drunkenness, maintained the opinion, that "much of the (alcoholic) liquor enters the circulation, and gives there an additional stimulus."† But the reviewer of this work in the Edinburgh Medical and Surgical Journal endeavoured to refute this opinion, and urged, "that neither the blood, nor any of the excretions, when examined, give any indication of the presence of alcohol, or intoxicating substance."‡

* Dictionnaire de Médécine, tome xii. p. 489.

† Edinb. Med. and Surg. Journ. v. 1, p. 57.

‡ Vol. 1, p. 57.

To conclude the present Dissertation, I cannot select a more appropriate subject, than the consideration of the *direct* modes, in which alcohol may, when introduced into the stomach in sufficient quantity, exert its intoxicating effects. Without fear of contradiction, I may remark, that there is no subject in physiology, which has given rise to more controversy, and which, even at present appears to be involved in greater obscurity, than the *modus operandi* of narcotic poisons. Whilst some physiologists maintain, that the peculiar and deleterious effect of these poisons upon the nervous system, is entirely to be attributed to an impression upon the extremities of the nerves of the stomach, or other organs, to which they may be applied; others advocate an equally exclusive doctrine, and hold, that the narcotic first enters the circulation, and then produces an impression upon the extremities of the nerves, which, it is assumed, are distributed to the inner coat of the vessels; whilst others again, amongst whom I may mention Müller, are led to the conclusion, that all narcotic poisons, not excepting even concentrated prussic acid, the action

of which is instantaneous, exert their deadly influence directly upon "the central organ of the nervous system," by actual transference to this organ.* I shall not enter upon an elaborate discussion of the various arguments which may be adduced, both in favour of, and at variance with, each of these theories. I shall merely endeavour to shew, that the narcotic effects of alcohol cannot in all cases be satisfactorily explained by adopting exclusively, either the theory of an impression upon the extremities of the nerves, or that of direct action upon the central organ of the nervous system.

If it be maintained that the narcotic effects of alcohol, in other words, *the cerebral derangement which alcohol produces*, depends exclusively upon a peculiar impression upon the extremities of the nerves, we should certainly expect that this cerebral derangement would, in every instance, almost, if not, instantaneously succeed the exhibition of alcohol, especially when in large quantity and in a concentrated form. On a careful review, however, of the experiments detailed, it will be

* Elements of Physiology, p. 247.

observed, that generally an interval of several minutes elapsed before the slightest manifestation of cerebral derangement was afforded. Hence it is inferred, that in some, or rather in the greater number of cases, absorption is required for the development of the narcotic effects of alcohol; and that the central organ of the nervous system is then directly affected. And in support of this inference, may also be adduced the experience of Dr. Christison, who states, that in some experiments performed by Dr. Coindet and himself, the alcohol "appeared to act not so swiftly, but that absorption might easily have taken place before its operation began." *

In some of the experiments, on the other hand, total loss of insensibility and voluntary power so instantaneously followed the introduction of the poison into the stomach, that, as I have before remarked, we cannot, notwithstanding the rapidity with which we have seen that alcohol may be conveyed from the stomach to the brain, conceive that absorption to a sufficient extent could possibly have been instantaneously effected. Hence,

* Christison on Poisons, 3d ed. p. 843.

although I acknowledge the evidence is not absolutely conclusive, yet little doubt, I think, can be entertained that alcohol may produce its narcotic effects, and even induce a fatal termination, without being absorbed. The question then arises, whether these effects depend upon an impression upon the extremities of the nerves ? Unfortunately, it would be extremely difficult, if not impracticable, to determine the solution by direct experiment. Yet, unless we respond in the affirmative, it is impossible to explain how the brain and nervous system in general should be so instantaneously affected. That an impression may be directly transmitted from the stomach to the brain, is proved by the remarkable sympathy which is known to exist between these two organs; for on no other principle than that of nervous communication can this sympathy be explained.* A *slight* blow on the stomach may cause immediate death, and, as far as we can conceive, in no other manner than by producing an impression

* I might also mention the well-known fact, that death is frequently caused by wounds and extensive burns, of which the effects can on no other principle than that of nervous impression and communication, be conceived to be commensurate with the fatal result.

which is transmitted to the whole nervous system through the medium of the gastric nerves. Now, is it unreasonable to suppose, that alcohol, which, be it remembered, is a powerful narcotico-acrid poison, may, when introduced into the stomach in sufficient quantity, cause death in a similar manner ?

It has, I am aware, been objected, that the circumstance of the symptoms of intoxication being, in some instances, almost instantly abated by vomiting, is incompatible with the idea that alcohol may act by absorption directly upon the “ central organ of the nervous system.” But, independently of the facts that alcohol may be detected in the brain, and blood, I may answer,—*firstly*, that in dogs I have never (although I have watched with great attention) seen such immediate abatement even after repeated and violent vomiting, as is generally represented to take place in the human subject;—*secondly*, that even admitting the correctness of the observation upon which the objection is founded, the very act of vomiting may probably be a sufficient stimulus to account for the subsequent relief; and this is sup-

ported by the current opinion, that vomiting is much more efficacious than complete evacuation by means of the stomach-pump;—*thirdly*, that I recently witnessed a case of profound intoxication in a man, in which complete evacuation by the stomach-pump was not attended by any immediate abatement of the symptoms: indeed, the intoxication suffered no diminution for two or three hours afterwards; during which time the breath continued strongly alcoholic.

Again;—it may be objected that alcohol produces an equally powerful effect, when the pneumo-gastric nerves are divided; but the objection is at once removed, when it is remembered that the sympathetic nerves remain uninjured.

FINIS.

ERRATA.

Page 3, line 11. *For* "is generally," *read* "would probably be."

Page 27, line 19. *For* "æsophagus," *read* "œsophagus."

